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ABSTRACT

The purposes of this Unesco workshop were to: (1) share experience gathered during national level workshops and identify problems, growth points, and methodologies of innovative projects, particularly those with focus on the use of locally available resources and environment as an alternative to and complement of laboratories: (2) based on the synthesis of the above experiences, develop guidelines for designing, developing, and implementing science curricula based on the materials derived from and linked with real-life situations and employable skills associated with them, using the environment and local resources: (3) suggest alternative methods for preparing teachers of science and technology education for implementing science curricula related to real-life situations, using environment and local resources: and (4) recommend follow-up activities, both at the national and regional levels. (Author/SK)

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APEID

ASIAN PROGRAMME OF EDUCATIONAL INNOVATION FOR DEVELOPMENT

Linking science education to real life

curriculum design, development and implementation

Report of a Sub-Regional Workshop on Designing and Developing Innovative Science Curriculum and Instructional Materials

Colombo, Sri Lanka
10-22 December 1979

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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Chapter I

INTRODUCTION

Background

In the schedule of activities of APEID under the area of Science (including mathematics) and Technology Education, this Sub-regional Workshop on Designing and Developing Innovative Science Curriculum and Instructional Materials was organized jointly by the Curriculum Development and Teacher Education Division, Ministry of Education, Sri Lanka, and Unesco's Asian Centre of Educational Innovation for Development, Bangkok, from 10 to 22 December 1979 at the Curriculum Development Centre, Colombo (Sri Lanka).

Prior to this Sub-regional Workshop, a Preparatory Group Meeting was organized in early September 1979 which developed guidelines for the organization of national workshops in the participating countries and this Sub-regional Workshop. During the month of November 1979, the participating countries organized the national workshops to deliberate on national experiences relating to the designing and developing of innovative science curriculum and instructional materials. In addition to the above two activities, a Mobile Field Operational Seminar was also organized during August 1979, which made an in-depth study of selected science curriculum development projects in India and the Philippines. The participants of the Mobile Field Operational Seminar were actively involved in the organization of the national workshops in their respective countries and subsequently participated in this Sub-regional Workshop also.

Purpose of the Workshop

The main purpose of this Workshop was to:

1. Share experiences gathered during the national-level workshops and identify problems, growth points and methodologies of innovative projects, particularly those based on real-life experiences with focus on the use of locally available resources and environment as an alternative to and complement of laboratories;

2. Based on the synthesis of the above experiences, develop guidelines for designing, developing and implementing science curricula based on the materials derived from and linked with real-life situations and employable skills associated with them, using the environment and local resources;

3. Suggest alternative methods for preparing teachers of science and technology education for implementing science curricula related to real-life situations, using environment and local resources; and

4. Recommend follow-up activities, both at the national and regional levels.

Participation

Twenty participants, two each from Afghanistan, India, Japan, Malaysia, Nepal, Philippines, Socialist Republic of Viet Nam, Thailand, and four from Sri Lanka, participated in the Workshop. The participants represented science curriculum developers, science teacher educators and science supervisors. The list of participants is in Annex I.

Inaugural session

The Workshop was inaugurated by Dr. Nissanka Wijeyeratne, Honourable Minister of Education and Higher Education, Sri Lanka, in the auditorium of the Nalarda College, Colombo. The Hon. Minister, in his remarks, thanked Unesco for the varied activities which have been of immeasurable benefit to the people of the different regions of the world. He said that the designing and developing of innovative science curriculum and instructional materials was of particular relevance to the countries represented at the Workshop. The designing of instructional materials, he said, is concerned with the problem of transmission of knowledge, and that this transmission is directed towards children. Therefore, it must be designed to benefit the children and no one else. He stressed the need for continued study based on feed-back in the development of the curriculum. With reference to the development of innovative science curriculum, he stressed the importance of gearing it to the needs of developing countries like Sri Lanka, which have remained for long producers of primary products. He said that science must help these countries to develop the technologies necessary to develop manufacturing processes based on their own natural resources. He said that the private sector has a role as important as that of the public sector in achieving this transformation and that institutional opportunities, available in the private sector should also be harnessed and recognized. He also drew attention to technological and innovative skills based on scientific principles which were present in our ancient civilizations, which should be studied and adapted to present-day needs.

The inaugural session was also addressed by Mr. D.M.P.B. Dasanayake, Secretary, Ministry of Education. In his address, he said that science education per capita-wise was expensive because of its dependence on imported equipment and technology, and that

researchers and scientists trained abroad often could not adapt themselves to local conditions. He stressed the need to relate scientific research and learning to our own eco-systems and our own environment.

Mr. George Mendis, Deputy Director-General of Education, welcomed the participants.

Dr. M.C. Pant conveyed the thanks of Unesco to the Ministry of Education for agreeing to jointly host this activity and briefly explained the nature of the Asian Programme of Educational Innovation for Development (APEID), and particularly the focus of various activities in the area of science and technology education.

Mr. W.S. Perera, Director of Education, Curriculum Development Centre, proposed the vote of thanks.

Method of work

During the first plenary session, the participants elected Mr. W.S. Perera (Sri Lanka) as Chairman, Mr. Nobutaka Ito (Japan) and Mr. D.L. Shrestha (Nepal) as Vice-Chairmen and Miss R.A. Valle (Philippines), Miss N. Chelladurai (Malaysia) and Dr. G.K. Lehri (India) as Rapporteurs.

The Workshop then adopted the agenda and the schedule of work.

The first four plenary sessions were devoted to the presentation of and discussions on the experiences of the national workshops. This was followed by a field trip to make an on-the-spot study of some science projects which had real-life situations as their main focus. Opportunity was also taken during this field trip to identify various resources available in the environment and real-life situations which could be used for developing science learning experiences. One plenary session was then devoted to the general discussions on problems and issues in science education as also to determine strategies for developing the guidelines. The Workshop then divided itself into three groups to develop guidelines relating to science teaching at the primary, secondary and higher secondary stages of education, as well as alternative strategies for preparing science teachers. These guidelines were then considered in two plenary sessions and were finalized by the groups, taking into account the comments of the plenary.

In another plenary session, the Workshop made recommendations for follow-up actions both at the national and regional levels.

In the concluding session, the draft report was considered and adopted with certain modifications.

The deliberations of the Workshop and guidelines are embodied in the following chapters.

Chapter II

HIGHLIGHTS FROM THE NATIONAL WORKSHOP EXPERIENCES

Presented in this chapter are the highlights from the reports of the national workshops which were presented in this sub-regional workshop and provided the basis for developing guidelines on curriculum designing, curriculum development and curriculum implementation, with particular reference to linking science learning to real-life situations with focus on the use of environment and locally available resources. Though the broad guidelines for organizing these national workshops had been developed by a Preparatory Group Meeting, these were subsequently modified by the participating countries to focus the deliberations of the national workshops on their ongoing science education problems and programmes and how these could be geared to link the science learning to real-life situations and the environment. The national workshop reports therefore reflected a variety of ways in which the whole problem of bringing in relevance in science teaching-learning programmes can be viewed so that they would be contributive to national development goals and will be linked to real-life situations. In a number of these national workshops specific innovative projects which are being implemented to link science education to development goals and real-life situations were discussed and analysed.

The inventory of these projects is included in Annex II of this report. The list of papers which were presented in these national workshops is indicated in Annex III.

Some of the national workshops also developed guidelines for designing, developing and implementing such science curricula and for preparing teachers for its effective implementation. Though these have not been included as such in this chapter, they have been made use of in developing the guidelines by this Workshop and are reflected in Chapter III of this report.

AFGHANISTAN

Organization of the National Workshop

The National Workshop developed operational guidelines for the organization of the Workshop based on the goals of the Great Saur Revolution which are:

1. Ensuring of universal, compulsory and free primary education to all children of school age and creation of all essential provisions for effective struggle against illiteracy;

2. Expansion of free intermediate, high and vocational education in order to train academic and professional cadres required for the economic progress of the country and review of curriculum of the schools and of institutions of higher learning;

3. Creation of a progressive national, cultural system and in the first step ensuring of conditions essential for evolution of art and literature, education and publications in the mother tongues of tribes and nationalities resident in Afghanistan.

Thirty-one representatives from the National Science Centre, Curriculum and Textbook Project, Departments of Compilation and Translation, Primary Education, Secondary Education, Teacher Education, Literacy, and Kindergarten, of the Ministry of Education together with representatives from the Ministries of Planning, Higher and Vocational Education, and Rural Development, participated in the Workshop.

Science curriculum

1. Primary science

In the primary science curriculum, all efforts have been made to cover the goals and functions of the Revolutionary Government, aims of education, objectives of primary science, educational needs of the pupils and the needs of the society. In the present primary curriculum, science is not taught in grades I and II as a separate subject, but a part of science is combined with health and environment and is taught in an integrated manner with other subjects. In grades III and IV, science is taught as a separate subject. After grade IV the science syllabi are arranged in a spiral form (spiral curricula). The following table shows the different science disciplines with the number of periods per week and totally per year.

No.	Subjects	Grades levels	No. of periods per week	No. of periods/ school year
1.	Nature	3	2	64
2.	Nature	4	2	64
3.	Biology	5-6-7	2-2-2	64-64-64
4.	Physics	6-7-8	3-3-2	96-96-64
5.	Chemistry	7-8	2-2	64-64

Linking science education to real life

Primary science is mainly focused on environmental aspects and the syllabuses have been completed up to grade VII in Dari. According to a plan they will later be prepared in Pashto, Uzbaki, Turkmani, Baluchi and Nooristani. Contents are developed keeping in view the developmental stages of the pupils and are functional. The core of the programme is based on real-life problems and realities of the environment. Writing textbooks for the respective grade levels is in process. The textbooks have been prepared in such a way that each lesson requires the students to perform at least one real-life experiment related to their environment making use of environmental material and local equipment. The textbooks are supported with teacher's guide which help the teachers to understand the aim of a lesson and particular methods of teaching and experiments that could be performed making maximum use of simple environmental materials that could help the students to develop the ability to solve their daily life problems.

2. Secondary science

These programmes are designed using a spiral approach, related to the real-life situations of the learners. The last classes of the secondary education are divided into social and natural science streams. Graduates from the secondary level are divided into vocational and higher education institutions for further training.

Laboratory technicians' training

Technicians are of great importance in organizing science laboratories and helping the science teachers during performance of experiments, particularly at the secondary level science teaching. Previously the laboratories lacked qualified technicians, therefore, immediate action was taken and the Laboratory Technician School was expanded. The programmes are arranged in such a way that theoretical and practical parts are balanced. Fifty per cent of the teaching periods are devoted to science teaching and practical laboratory activities.

Environmental education

Ever-increasing problems of the environment have endangered all the countries of the world. Afghanistan has also taken steps to identify and solve environmental problems and conserve available natural resources. Recently with the support of Unesco an environmental education pilot project was implemented for grade VII students in twelve schools (600 students) of some provinces situated in ecologically different regions.

Innovations in the educational system

Effort is being made to include science and technology in the educational system so that the learners utilize these in their daily lives. Some of the innovations brought about in various educational processes are:

1. Instructions in the native languages or one of the national languages. Free choice of the language in which the learners study.
2. Linking education to real-life situations of the children and utilizing locally available resources.
3. Providing a practical approach to education and continuous improvement of the programmes on the basis of science, technology and culture.
4. In addition to the regular lessons, the students are provided with practical activities, out of class activities, laboratory work, field trips, professional gatherings, work in professional workshops, carpentry, lathe operation, smithy, pottery, weaving, work on the school experimental farms and work in the library.
5. In the new curriculum recently introduced, science is learnt as nature study in grades III and IV, biology from grades V to X, physics from grades VI to X, and chemistry from grades VII to X.
6. Graduate teachers are trained according to the following three methods.
   (a) Specialized education (native language, mathematics, nature study, etc.)
   (b) General pedagogical education (anatomy, physiology, psychology, etc.)
   (c) Professional training (teaching methods, observation, etc. in a practical manner).
7. Effort is made to utilize simple, locally available material during science teaching.

Implementation - materials and training

Since instructional materials are the basic and essential elements of the teaching/learning process, it is necessary that developing countries with limited resources utilize to the maximum locally available materials instead of relying on very expensive imported materials. In order to achieve this, it is very important to develop centres or units for preparation and production of the low cost

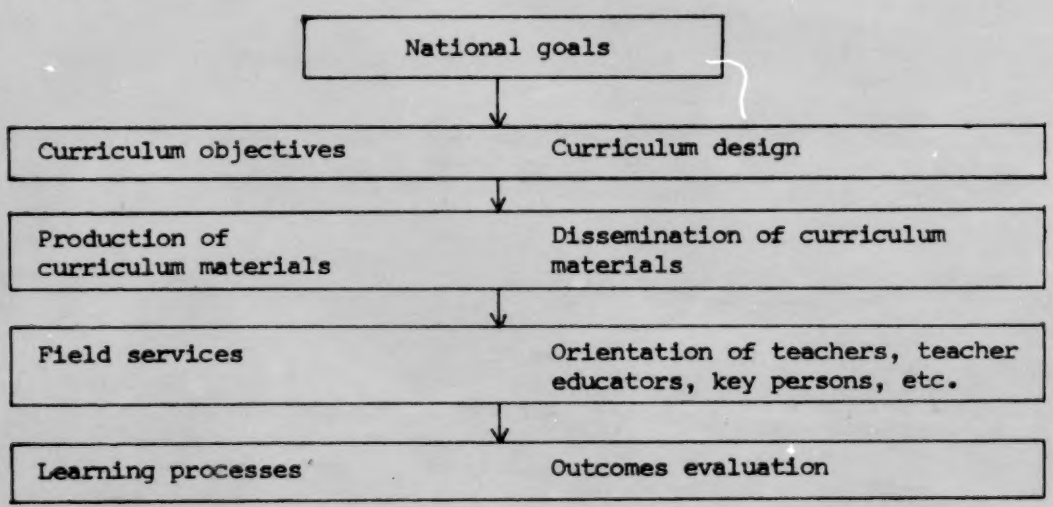
materials utilizing indigenous resources. A beginning towards this has already been made in the National Science Centre and the Audio-Visual Unit.

The effectiveness of innovation brought into the science education programmes does not only depend on how the instructional and supplementary materials are prepared, but rather on how effectively the prepared materials are linked to the locally available resources by the teachers. Therefore, being the pivot of the teaching/learning process the teachers need training and are being trained through pre-service and in-service programmes through a variety of institutions.

In order to help primary teachers to upgrade and to update their science knowledge and skills, workshops and seminars are organized. During the seminars authors and councillors from the Ministry of Education shed light on the textbooks, different methods of teaching, utilization of the locally available materials and the evaluation of pupils learning. During these in-service programmes some skilled teachers are selected and employed as science supervisors in order to promote the new science curriculum in a proper way.

The National Science Centre is in charge of the in-service science education for teachers of the secondary level, supervisors and laboratory technicians.

During the implementation of the new programmes and considering the innovations and linking the curriculum with the present and future real-life situations the following points would have to be taken into account:



Evaluation

For the new curriculum, the content of the experimental text-books, teachers' guides and supplementary materials are evaluated chapter wise and as a whole, in one class or in a school by the teachers, authors and councillors.

The Ministry of Education is planning to establish a Pedagogical Centre. Evaluation of instructional materials will henceforth be the responsibility of the Research Department of that Centre.

Problems

When a new curriculum is introduced and implemented, it would certainly cause some difficulties. In introducing and implementing the science curriculum, the Ministry of Education is facing the following difficulties: Schools without buildings; lack of proper and sufficient instructional means and materials; the majority of the people are illiterate; lack of proper plans; lack of precise statistics based on scientific research in all educational fields; lack of a proper dictionary of scientific terminology in the national languages; lack of qualified science supervisors and a proper supervision system.

Proposals

In order to overcome the problems and improve the science education some of the main proposals made by the Workshop were:

1. To improve the cadres of the educational institutions of the country it is necessary to train the professional persons in the country and abroad.
2. In order to enrich and link science education with real-life situations, it is necessary to establish co-operation between various organizations in the country such as health, agriculture and industry ministries and ministry of education.
3. The developing countries have always the problem of resource constraint, both human and financial. To overcome the problem, the teaching/learning materials as much as possible should be provided and developed from local resources based on low cost materials.
4. Training of professional and qualified supervisors for each subject area is needed and is necessary.
5. Exchange of materials, personnel (short-term and long-term), particularly to study innovative experiences on utilizing natural resources in science education should be strengthened. A beginning should be made with the teaching/learning materials with other countries of the region.

6. To improve and avoid duplication of activities, the National Science Centre, Educational Radio T.V., and Compilation Department should be joined under one administrative office.

7. Continuous evaluation of the implementation of the new curriculum at the national level and its relation with the regions must be carefully monitored.

8. Teacher training institutions and related Faculties of the University which train the teachers should correlate their training programmes with the school science curricula.

9. The idea of establishing a Laboratory Technician School is new and innovative and based on real needs. Training the staff, increasing the budget, and promotion to a higher level should be considered.

10. Environmental Education started as a pilot project with the aid of Unesco is a new thing in Afghanistan and there is a need for training the responsible personnel and improving the budgetary provisions.

11. In accordance with the Government plans, the science curriculum has been changed in grades I to X. As a result of this, increased needs of materials and equipment are strongly experienced at primary, secondary and teacher training levels. It is thus suggested to import raw materials, produce and distribute equipment at the National Science Centre and Audio-Visual Institute.

12. For the popularization of science and technology in the country it is necessary that Unesco should be actively involved at the primary education level.

13. It is proposed that sub-regional workshops should be held also in Afghanistan.

INDIA

The National Workshop on Designing and Developing Innovative Science Curriculum and Instructional Materials was organized at the Regional College of Education, Bhopal, from 22 to 27 November 1979, keeping the terms of reference given by the Preparatory Group Meeting.

During the Workshop, the participants had ample opportunities for interaction among science curriculum developers, science teacher educators and experts from different fields. The Indian participant of the Mobile Field Operational Seminar shared his rich experiences gathered during the Seminar with other nationals. The participants shared their experiences from their respective states with regard

to a number of innovative curricula and projects. A comprehensive inventory of innovative curricula and projects were prepared followed by a detailed discussion,keeping in mind the following criteria:

1. Rationale of the project;
2. Problems which are being met through the project;
3. Main strategies and methodologies used in the development of the project;
4. Implementation;
5. Evaluation;
6. Innovative features of the project and problems faced;
7. Exemplars of the instructional materials used in the project.

The participants laid down criteria for identifying innovations. It was accepted unanimously that the following aspects could be kept in mind while making an intensive study of innovations in science and technology:

1. Emphasis on change in terms of planning a strategy to deal with specific problems;
2. Novelty;
3. 'Deliberateness' and 'specificity' to bring about desired changes;
4. Transferability and multiplying effect;
5. Adoptability or adaptability;
6. Simplicity;
7. Local acceptance;
8. Clarity about inputs and outputs;
9. Relevance - as per local needs; and
10. Awareness in respect of allied problems.

An inventory of selected curricula and projects in science discussed in the Workshop is given in Annex II.

The participants discussed the existing strategies for teacher education in the country. They also discussed the short-comings in the teachers as identified by the teacher educators and the supervisory staff from the point of view of the need of linking science learning/teaching with real-life situations, using environment and

local resources. This diagnosis led to identification of problems, and successful strategies. Guidelines on alternative strategies for teacher education programmes were then formulated.

Problems

1. Teachers having completed pre-service or in-service programme successfully both from their own perception or that of trainers, do not implement it on the job.
2. The motivation generated during the training programme is not sustained for long and soon dies out.
3. Lack of integration of content with methodology during training programme, inhibits its transfer to actual class-room situation.
4. Absence of self-learning techniques in training programmes is not conducive to professional growth after the training.
5. Teachers teaching methodology have no contact with the actual school situations, with the result that they fail to generate confidence in the methods they advocate.
6. Training programme is predominantly theoretical, while adequate practical experience is essential for acquisition of appropriate skills.
7. The programmes of teacher education are more course based rather than competency based.
8. Structured training programme for improvisation, maintenance and repair of apparatus is wanting.
9. The training programmes lack the optimum utilisation of school and community resources for teaching/learning situation.

Strategies

1. Emphasis should be laid during training programme on motivating a teacher for applying his acquired knowledge continuously in the classroom situation.
2. Sufficient motivation should be provided during the training programme in order that it may be sustained during their professional career.
3. Content and methodology should be integrated so that it becomes a desirable experience.
4. Sufficient self-learning techniques should be provided to the teacher in order that he continues to grow academically and professionally.

5. Training programme should cover all aspects of school activities to be undertaken by the teacher. More emphasis should be laid on diagnostic testing followed by remedial measures.

6. Teachers teaching methodology courses should continue to teach at the appropriate level in the schools so as to be in touch with real classroom situations. Moreover, these classes could be used as demonstration so that the trainees can observe the effective use of different techniques of teaching.

7. Fundamental concepts of science should be identified and appropriate learning experiences should be provided during the training period.

8. Proper integration of theory and practice should be evolved. Theoretical knowledge should be appropriately implemented in the practice of teaching so that required level of skills is developed.

9. Sufficient training should be provided for identifying available teaching aids and their proper utilisation and effective use in the classroom.

10. Adequate training facilities be provided for improvisation, maintenance and repair of apparatus normally used in schools.

11. Training programme should enable the teacher to identify materials and resources from the environment that can be effectively used.

12. Importance of rapport between teacher, parent and community at large, should be emphasized during training.

13. Importance of the role of supervisor in the professional growth of the teacher should be emphasized during the training programme so that desirable harmonious rapport can be developed.

The participants prepared guidelines for developing teacher education programme to cater to the need of linking science learning/teaching with real-life situations using environment and local resources. Stress was laid on both pre-service and in-service programmes of teachers.

As a follow-up of the National-Level Workshop, the following recommendations were made:

1. Workshops may be arranged for suggesting alternative specific designs for a science curriculum linking science learning/teaching with real-life situations and using

environment and local resources. They should also formulate curricula for teacher education for this specific need.

2. Alternative designs of science curricula suitable for the effective participation by the educationally disadvantaged sections of the society have to be formulated.

3. Educational researchers have indicated that most of the learners can be categorised as either at 'concrete level' or at 'formal level.' Separate instructional strategies have to be developed for these categories of learners.

4. The Cell of the NCERT, existing at present, which maintains an inventory of innovative projects should be strengthened both from the points of view of finance and manpower so that an effective agency comes into being at the national level.

5. In educational administration, research institutions and voluntary organizations, a cell should be set up charged with the responsibility to initiate innovative projects in science education, keep an inventory of on-going projects and to monitor such projects.

6. The State Institutes of Science Education/SCERTS/NCERT, should keep an inventory of voluntary organizations engaged in innovative projects in science education and fund them wherever necessary.

7. There should be committees at the national, state and district levels for evaluating the innovative projects. The membership of these committees should be restricted only to those who are actively involved in such projects, but with provision for co-opting a few experts.

8. The multiplication of an innovative project has to be effected through an organization which mobilises all possible local resources.

9. An association of science education innovators should be established at the national level with branches in all the states with membership open to all interested. This organization should have a journal through which dissemination of innovative projects and information on the possible funding agencies can be provided to the innovator.

10. The educational administration should be decentralised so that sufficient freedom is available to the innovator for effective implementation of his projects.

11. More opportunities should be provided for innovators in the field of science education using local resources for first-hand experiences of such activities in developing/developed countries.

JAPAN

The main activities of the national workshop comprised of the presentation of the experiences of the on-going projects and curricula; review of the on-going projects and curricula for linkages with real-life situations; using environment, community resources; developing low cost materials; and pre-service and in-service training of teachers. Several papers were presented, concerning the activities of the Science Teacher Associations, and the present situation of in-service training in Science Education Centres based on the newly revised official curriculum (1980).

The newly revised curriculum (1980) emphasizes the following: Pupils' abilities for and a positive attitude towards making inquiries about nature and natural phenomena through observations and experiments, as well as to enhance their understanding of the matter, thus to have the pupils realize the relationship between nature and human beings.

Under these circumstances, the revised curriculum provides for learning experiences linked to real-life situations and the use of the environment and community resources for teaching.

Following are some of the practical examples which would illustrate how science curricula and instructional materials could be developed for establishing linkages with real-life, using community resources and in-service training activities in the science education centres.

1. A stone face (Elementary school, grade I)

When the children in the craft class were asked to select a piece of stone and make a face, there was a tendency to select a large piece of stone. However, after the children had played with different types of stone in the science class, they were able to select a stone of a shape, colour, smoothness and pattern suitable for the face they intended to make.

2. Let's play with hamsters (Elementary school, grade I)

The children were all given a job (feeding the hamsters, cleaning the box etc.) and were then asked to write about what they had done. The questions and reactions of the children (why ...? what ...?) increased as instruction became more detailed. It was also noticeable that in almost all cases (34 out of 40) pictures drawn by children after they had taken care of the hamsters were more detailed and correct than those drawn before.

3. Investigating strata at the river bank (Elementary school, grade VI)

By observation of the strata on the spot, the children were also to formulate the following questions and deductions:

i) Why is there a large-grained stratum (stones) above a small-grained stratum (sand)?

In the slow current down-stream sedimentation frequently occurs. Large stones are swept along and deposited when floods occur.

ii) Why is red earth (clay) common at the sides of the river?

This is probably because stones and sand are swept away by the current, leaving strata of red earth (clay).

The children also found metasequoia fossils and showed great interest in fossils.

4. Drawing a map of the surrounding district from the top of Mt. Marudake (Elementary school, grade VI) - Investigation by the NIER

To investigate their awareness of space in their environment, seventy-three children were taken to the top of Mt. Marudake and given 20 minutes in which to draw a map of their surroundings.

One group (A Group) was told: "Draw in such a way that you can talk about this place afterwards to your family" and one group (B Group) was told: "Draw in any way you please." Almost all the children drew what they could see by looking down diagonally. In addition, 54 per cent of the children drew a radial map.

The arrangement of features on the map was more accurate in the case of A group than in the case of B group.

5. Place names and topography (Junior High School, grade III)

By establishing a connection between regional place names and topographical features, topography becomes easier to understand. For instance, in the Yamanote area where the effects of erosion by a river are evident, there are many names which incorporate such elements as 'dai' (plateau), 'saka' (slope), 'tani' (valley), or 'yama' (mountain). Lower downstream in the 'downtown' area where the current is slower there are many names with the element 'hashi' (bridge). Also, place names with the element 'to' (door) meaning 'inlet' or 'kaizuka' (heap of shells) bear witness to former topographical features.

6. Making hard caramel (sugar sweets) (Junior High School, grade I)

By observing dissolution (physical change) and hardening (chemical change), changes in matter become easier to understand.

Method: Place sugar and a little water in a large ladle and heat gently while stirring well. When the water has evaporated and the stickly mixture can be drawn out like a thread, add some bicarbonate of soda. Stir vigorously and when the mixture expands, remove from the heat.

7. Extracting camphor from the leaves of camphor tree, (Junior High School, grade II)

By means of using natural materials for separation, methods of separation can be confirmed.

Method: Collect camphor leaves and dry in the sunlight. Crumble 30 to 40 grams of dried leaves in your hands. Put the powder into a flask and just cover with water. Heat and convert to vapour and back to a solid by sublimation. Filter and dry (yield 1%)

8. Guidance in using folk-art products

From olden times folk-art products have been used as teaching materials.

(a) Rubber gun (1st grade)

Makes children aware of how objects can be made to move (fly) by using rubber and how the movement of toys varies according to the strength of the rubber

(b) Balancing toy, self-righting toy (Elementary, 2nd grade)

Makes children aware of how movement varies according to the heaviness and placing of a weight.

(c) Water-wheel and windmill (Elementary school, 3rd grade)

Makes children aware of how movement varies according to the strength and position of the water or wind.

(d) Thread telephone (Elementary school, 2nd grade)

Makes children aware of how sound can be transmitted by the vibrations of a thread.

(e) Blocks drop down (Senior High School)

Proving the First Law of Dynamics (Conservation of Inertia).

9. The following points were raised as other examples:

(a) What is the best way to move heavy objects?

Use of lever, pulley, rollers.

(b) What happens when objects are exchanged?

Weight - measuring with a balance.

Size - measuring with a rule.

(c) When you boil sea water, what happens?

Salt remains. If you put the salt into the fire, the flames can be seen to undergo a colour-change reaction.

(d) What is the best way of increasing crop yield?

Investigate the effects of sunlight and shade, and of close sowing and spaced sowing.

(e) Can dangerous animals be identified by their tracks?

Investigate the difference in the footprints of carnivores and herbivores.

(f) Under what sort of conditions do things dry quickly?

In conditions of high temperature and low humidity and when there is wind.

(g) Why is it hot in the day time?

Investigate the connection between the position and heat of the sun.

(h) How can one obtain good drinking water?

Carrying out distillation, filtering or boiling.

(i) If one boils plants, what will be left?

Carbon. Learning to understand that plants contain carbon.

There was also discussion at the workshop on the connection between language and science.

(a) <u>Examples from elementary school</u>

As children get more used to reporting experiments and observations, their expressions become more accurate. Also, they acquire a wider range of expressions through experience and enjoyment. However, when the children are given guidance in how to distinguish between fact and deduction or how to form complete sentences, the range of expression becomes less and their level of activity decreases.

(b) Example from Junior High School

In a class of about 40 pupils, only one or two pupils could use expressions correctly.

(c) Planning

In Japanese, there are only a few expressions which are common to both scientific and everyday language, so an accurate grasp of scientific concepts is not easily obtained. But it is perhaps necessary to teach the use of scientific expressions and the pronunciation of special terms.

Teacher training

Training in basic ability and acquisition of basic techniques needs to be emphasized. (Observation, memory, processing, planning, developing ideas)

Practical experiences need to be provided so as to develop a correct attitude towards nature through such activities as field trips, nature tours. In particular, outdoor education is lacking at present.

In-service training

Experience of the Education Research Centres to enable teachers to undertake research appears to be an effective way of in-service training. Reactions of participants were:

- We were stimulated by the honest, practical reports of many other teachers.
- We were surrounded by good teachers.
- We were able to acquire new information.
- We gained confidence to continue our research.

MALAYSIA

The National Workshop was organized jointly by the Teacher Training Division and the Curriculum Development Centre of the Ministry of Education, Malaysia, from 14 to 20 November 1979. A total number of twenty-two participants comprising officers from the various divisions of the Ministry of Education as well as lecturers from three universities in the country participated in this Workshop. Prior to deliberations on the issues relating to the objectives of the Workshop, the participants were briefed on the background relating to the aims of the Workshop. Although numerous

community based projects can be identified in the country, these are mainly carried out by the Ministry of Agriculture, Malaysia. Information on these community projects are reported in the Workshop proceedings and in the paper. "Identification of Community Resources and Local Expertise in Community Development Programmes". As such, participants of the Workshop confined their deliberations to linking real-life situations to the existing science curriculum. The following are the outcomes of their deliberations:

1. To provide the necessary basis for reference in linking real-life situations to science teaching/learning using environment, community resources and local expertise, the following definitions have been agreed upon:

(a) Environment is defined as the physical, biological, socio-economic and cultural factors which, directly or indirectly, influence and interact with the life of an individual.

Examples of aspects of each of the factors are:

physical	:	air, water, forest ...
biological	:	food and nutrition, ecology ...
socio-economic	:	health, housing, utility services
cultural	:	values, attitudes, art ...

(b) Community resources are defined as resources or facilities available in a community. These may be put under the two categories of urban and rural, which can further be grouped into government and non-government sponsored. Some examples are given below:

	Government sponsored	Non-government sponsored
Rural	- Fishing	- Youth club
	- Forestry	- Co-operative society
	- Agriculture	- Cottage industries
Urban	- Chemistry department	- Factories
	- Museum	- Professional bodies
	- Public utilities	- Workers' Unions

Apart from the above examples, national parks, public gardens, etc., could also be considered.

(c) Local expertise is defined as specialized knowledge and skills available in a local community.

Examples of people who can provide local expertise are as follows:

- teachers
- accountants
- sculptors
- artists
- fishermen
- doctors
- carpenters
- technicians
- 'dukun'/'pawang' (traditional medicine men)

2. In reviewing the existing science curriculum for the primary and the lower secondary level as well as the Teachers' Colleges, it is found that there are many topics in the curriculum which lend themselves to link science to real-life situations in respect of environment, community resources and local expertise. However, it is felt that not enough emphasis has been given for such linkages in the teaching of science at the respective levels. The insufficient emphasis may be due to the following reasons:

(a) Linking science to real-life situations, and using environment, community resources and local expertise has not been specifically spelt out in the objectives for the curriculum concerned. (It must be pointed out, however, that this linkage has not been taken to be an objective specifically when the curriculum was developed).

(b) Heavy emphasis on examinations.

(c) Insufficient time available in the time-table for such experiences.

(d) Insufficient experience for imparting such experiences on the part of some science teachers.

(e) Shortage of materials and supporting facilities.

3. The following methodologies are recommended to help link science experiences with real-life situations pertaining to environment, community resources and local expertise. In employing these singly or severally, various strategies could be formulated in providing science experiences with linkages to real-life situations.

(a) Visits

(b) Films, filmstrips, film slides

(c) Demonstrations

(d) Lectures or talks

(e) Briefings

(f) Discussions

(g) Projects

(h) Surveys

(i) Exhibitions

Linking science education to real life

4. Further to the above one or more than one of the following benefits may be derived from employing the methodologies/strategies stated:

(a) Observation of actual situations concerned;

(b) Active participation;

(c) Understanding through application/use;

(d) Awareness of problems/difficulties arising;

(e) Application of knowledge/skill in real-life situations;

(f) Exchange of views;

(g) Community service;

(h) Acquisition of information from afar/other communities;

(i) Understanding of methods used in application of skills; and

(j) Building up of rapport between community and school.

5. The following table suggests the various benefits that may be derived from each of the methodologies enumerated in the foregoing paragraph. In reviewing these benefits against the methodologies concerned, the various overall strategies could be designed, not forgetting the pupils and the level they are in.

Experiences with linkage to real-life situations

Benefits / Methodologies	I	II	III	IV	V	VI	VII	VIII	IX	X
Visits	+	+	+	+		+		+	+	+
Films, filmstrips, film slides			+	+				+	+	
Demonstrations	+		+	+		+		+	+	+
Lectures and talks		+		+		+		+	+	+
Briefings		+		+		+		+	+	+
Discussions	+	+	+	+	+	+		+	+	+
Projects	+	+	+	+	+	+	+		+	+
Surveys		+	+	+	+	+	+			+
Exhibitions	+	+	+	+	+		+	+	+	+

6. The Workshop developed one module each illustrating the application of methodologies and strategies recommended for the teaching of selected topics These are:

(a) The primary school level

The module on 'plants' illustrating vertically how the topics could be dealt with using environment, community resources and local expertise by stages over the six years of primary school education.

(b) The secondary school level

The module on 'petroleum' illustrating how real-life situations could be introduced or used in teaching it during the third year in the secondary school.

(c) The college level

The module on 'air' illustrating how the topic could be dealt with at the college level using real-life situations pertaining to environment, local expertise and community resources, to enhance its teaching/learning value for the student teachers.

NEPAL

Nepal has been striving for the improvement of science education for one and a half decades by trying various programmes to make it more meaningful and useful to the needs of the country. Based on previous experience in science education and the goals set by the New Education System Plan (NESP), a new science curriculum was developed and implemented. Schools were provided with science teaching materials and equipment as far as possible. Short term, on-the-spot teacher orientation programmes were conducted and the teachers were provided with curriculum and textbooks and guides.

However, the attempt to improve science education faced some major problems such as large classes; lack of standard and durable teaching equipment and materials; lack of teachers with adequate knowledge and background in linking science teaching/learning to local environment and making use of the natural resources; problems of transportation and communication. To overcome these problems, various programmes have been launched such as:

1. Science Innovation Project dealing with the development of science teaching materials from local resources.
2. Training of school supervisors and Master Teachers through national and regional workshops.

3. Radio broadcasts advising the teachers as well as students on how to use the local resources and environment in their science teaching/learning.

4. Development of handbook and posters describing how to conduct teaching/learning activities making use of local materials.

5. Survey of local resources available in different parts of the country which could help directly in developing learning activities linked with real-life experiences.

On the basis of the experience gained through various activities, the science curriculum has been thoroughly revised. This new science curriculum emphasizes the child's environment and his basic needs.

The outcome of the National Workshop is presented below:

1. Curriculum

Before developing guidelines for curriculum design, the Workshop deliberated on the following:

(a) Diversified geographical regions

Nepal, geographically, is divided into three different regions: i) Northern Himalayan Region; ii) Middle Hilly Region; and iii) Southern Terai Region. With this diversity, the real-life situations, the environments, community resources and the local expertise of these regions are different.

(b) Socio-economic situations

There are socio-economic and cultural differences in different regions.

(c) Community participation

The community participation is essential for any effective science education which attempts to link it with real-life situations, but the attitude and consciousness about the importance of science education among the community is still to be developed.

The following guidelines for action emerged as a result of the discussions at the Workshop:

a) Identification of the needs and resources of the community through surveys and interviews.

b) Preparation of a general curriculum, incorporating in the science activities the diversified real-life situations, local environment and the natural resources of the three different regions which could be implemented throughout the country.

c) Preparation of a glossary of the locally used technical words and made available to the teachers and the students.

d) The science activities in the classroom should be linked with the social and cultural activities of the locality.

e) Development of the attitude of the students and guardians through village system of communications, science fair, science clubs and also through linking village technology, namely Ghatta (hydro-rice mill), Ping (swinging rope), Janto (grinding mill) etc., to science and technology education.

2. Instructional materials

The implementation of NESP activity oriented curriculum was supported by a set of science kits distributed to all the schools in the country. But in practice, the science teaching was still not satisfactory. Some perceived problems are given below which may have implications for the development of instructional materials. These are:

a) Science kits could not be supplied to school in time due to transportation difficulties.

b) The number of kits were inadequate to meet the number of students in a school.

c) Lack of facilities for repairing and replacing of the equipment deterred teachers to use them.

d) Lack of separate science classroom.

e) Need for more adequately qualified and trained teachers

f) Teachers without science background were teaching science in some remote regions.

The above mentioned problems need to be kept in mind when preparing instructional materials for linking science to real-life situations, using environment, community resources and local expertise. The following guidelines for action are recommended:

a) Students to collect plants, small insects, rocks and minerals from their surroundings

b) Instructional materials should be prepared with the help and guidance of the teachers, involving them at every stage of development.

c) Mobilize the locality for the use of local resources and skills.

d) Teachers should be oriented to resort to the use of low-cost instructional materials found in various regions by conducting short-term workshops.

e) Organization of mobile exhibitions of the low-cost simple instructional materials.

f) Teacher's guides for an effective use of instructional materials should be made available.

g) Encourage the students by conducting exhibitions of the materials prepared by them and also showing them to their parents and local people.

h) Basic tools and basic materials should be made available to all the schools.

i) Students should be given a study tour of the local sites wherever the local technology can be linked with science teaching.

j) Science teachers should not be over loaded with too much work, which normally is the current practice.

k) Provision of separate science classroom in the school.

l) Experts from different sectors like agriculture, forestry be invited to give lectures to orient the students in these aspects.

m) There should be survey-study tours to construction sites, such as bridges, dams, to help students understand the scientific technology in the construction.

3. Teacher training

Teachers play a vital role in the effective implementation of any science curriculum. Lack of trained teachers is one of the greatest draw backs in Nepal. The Institute of Education (IOE) is trying hard to meet this demand.

Taking into consideration the above, the following suggestions are made:

a) To cope with the shortage of trained science teachers, the Workshop has suggested a short term training programme in which the teachers should be provided with the background of optimum skills to conduct science

classes efficiently. The short-term (intensive) teacher training courses should attempt to link learning with real-life situations, using environment, community resources and local expertise.

b) Learning activities in the regular pre-service training programmes should be linked with real-life situations, using environment, community resources and local expertise.

Training activities

a) Prepare a list of concepts and activities from the content of the textbook.

b) Collect local materials used in the real-life situations, using environment, community resources and local expertise according to the list prepared.

c) Design and develop instructional materials with the local materials collected.

d) Prepare lesson plans and try-out in the actual classroom situation.

e) Encourage interaction among the student-teachers.

f) Introduce teachers to proper management of science classes.

g) Arrange at the end of the training, an exhibition of all the instructional materials prepared during the training period.

Recommendations

Keeping in view the outcomes, the Workshop recommended the following:

1. Organize the Advisory Board, Task Force and Regional Committees, as a joint venture among the different educational agencies. (The Advisory Board consists of members mainly from CDC (TU), IOE (TU), Centre for Educational Research Innovation and Development (CERID), Research Centre for Applied Science and Technology (RECAST), Curriculum, Textbook and Supervision Development Centre (CURTES), Regional Education Directorate, District Education Office, Science Equipment Centre and the Schools).

2. Have a task force consisting of school teachers, school supervisors, science experts, to act as a standing group. This task force will be supported by regional committees and the co-ordination between the Advisory Committee and the task force should be taken care of by CURTES.

PHILIPPINES

The National Workshop was held from 26 to 29 November 1979 at the University of the Philippines Science Education Centre (UPSEC). Fifteen key people involved in various projects participated and delivered papers. Their projects fall under the following categories: (a) curriculum development; (b) teacher education; and (c) rural development. (For the title of the papers, please refer to the inventory given in Annex II).

After much deliberations and discussions on papers presented, the group came up with the following observations.

Innovations in elementary education

The innovations in elementary education were geared mainly towards the improvement of the quality of basic education. The projects such as Experimental Elementary Education Programme (EEEP), Integrated Programme for Science Education Development (IPSED), and Coconut/Abaca community science modules were premised on the need for a more relevant and stronger elementary education programme and how this can be effectively and economically delivered to a fast-increasing school population. An example of the latter is the project on Instructional Management by Parents, Community and Teachers (IMPACT).

The EEEP is a national level project aimed at strengthening the basic skills of literacy and numeracy which are weak areas for a majority of school children. This finding was revealed by a national survey conducted by the Ministry of Education and Culture on the basis of which the project was conceived. The IPSED, was initiated as a response to the poor performance of pupils as seen from a national survey. This project is focused mainly on the improvement of science education at the elementary level and is hoped to generate a similar effect at the secondary level.

While EEEP has wider coverage in terms of content and area of implementation, IPSED is more limited in scope, covering only the teaching of science and mathematics in the provinces of Leyte and Samar. The coconut/abaca project, on the other hand, is based on specific types of communities for which meaningful and relevant elementary science modules are to be developed. A more effective delivery system for mass primary education is the major concern of IMPACT. This five-year educational research and development project has come up with an alternative strategy for educating school children in the densely populated countries of Southeast Asia.

The programmes/projects are characterized by major changes in one or more of the following areas - curriculum, instructional approach, and strategy employed for development of curriculum materials.

Under the new curriculum design of EEEP, there are fewer subjects in the first three grades so as to concentrate on the development of the basic skills in reading, writing, and mathematics. Communication Arts in English draws content largely from science and health while Communication Arts in Pilippino derives subject matter from social studies. Work Education is introduced from the start of formal schooling with common activities for boys and girls to equip children with basic manipulative skills and positive attitudes towards work.

The outstanding innovative feature of Project IMPACT is the management of big classes by instructional managers composed of parents, teachers, and other community members, instead of having one teacher per class. Instructional aids in the form of learning modules are provided in the basic subjects, including science.

The new approaches being tried out under the multi-pronged thrust of IPSED are: (a) the use of modularized instruction in science and mathematics through locally and environmentally oriented learning units to enable school absentees to catch up with the rest of the class; and (b) in-service training of science and mathematics supervisors which is expected to result in more effective implementation of the programme at the school level.

A research phase to determine abilities of pupils (their cognitive level, knowledge of science processes, vocabulary level) and the activities/practices/common beliefs of the community precedes the actual writing of science modules for the coconut/abaca project. Active participation of community members is solicited in the survey, in prioritizing science topics, and in actual writing of materials for which some of them are tapped as consultants.

Common elements in terms of phases involved, and evaluation strategies used were observed in the projects. These were found to more or less undergo the following stages: (a) identification and assessment of needs, usually done through a survey; (b) design of a programme; (c) preparation of instructional materials; (d) orientation of tryout personnel and preparation of evaluation instruments; (e) actual tryout; (f) revision based on feedback. The evaluation procedure generally consists of pre and post tests, tryout feedback from teachers and pupils, periodic observation of classes. Except for project IMPACT which has been concluded, the other projects are still in the experimental or tryout stage.

Problems encountered in the projects are varied. EEEP suffered from problems attendant to orientation of school officials, materials distribution, and follow-up supervision. On the other hand, project IMPACT as a radical innovation had the problem of acceptability to the parents as well as the teachers, development of quality materials on schedule, training teachers on the new approach, and providing

the necessary facilities in cases of limited resources. In the case of IPSED, in addition to problems of inadequate resources, there were the problems of inaccessible schools, and heavy schedule of school activities, resulting in reluctance of teachers to attend training sessions.

Innovations in secondary education

The projects reported under this heading are addressed to two different groups of clientele, rural and urban students.

The projects were developed in response to real needs in the school environment. The Self-Sustaining School System (SSSS) answers the demand of graduates of the two-year vocational agricultural course in an agricultural college for a system by which they can complete the four-year vocational secondary course. To help in the development of the agricultural communities and to provide relevance of subject matter, a science curriculum closely linked to farming activities was designed. At this time, the Physics in Farming and Fishing Project of the UPSEC was launched, and the development of physics modules related to farming is now a cooperative effort between the staff of the agricultural college and the UPSEC.

The In-School Off-School Approach (ISOSA) at the Arellane High School, on the other hand, is addressed to the delivery of secondary education in urban schools. One common problem in many urban schools is the tremendous increase in school population. This results in a shortage of classroom instructional materials, and other facilities.

The innovations designed to solve the above problems involve either a change in the delivery system, curriculum content, or both. Under the SSSS concept, different sectors of the community actually run the school. Funding comes from the income of students, derived from their farming activities. Building and equipment are provided by the community. Supervision and maintenance of academic standards are done by the agricultural college. In the scheme of implementation, the first two years are devoted to vocational course, the last two for academic subjects. The curriculum emphasizes practical science education, e.g. inclusion in the science curricula of topics with utility value, use of the students' own farms for field-testing and supervised farming programmes.

While the content of the standard curriculum for high schools including the science curriculum, is preserved under the ISOSA, a change in the delivery system is effected. Students are in the school for one week and out of school the following week. During the off-school period, the students learn at home and in learning centres run by the community, with the help of self-learning kits or modules

The conceptual framework of the UPSEC community-based physics project is a total departure from that of a discipline-based instructional materials. Here, tasks/activities involved in farming and fishing are the main focus into which physics concepts are incorporated. Although, primarily intended for the formal setting, the modules can also be used by parents and other rural adults who can benefit from the applied portions of the material.

There is a difference in the methodology employed in the development of the rural and urban science curriculum materials. Unlike the rural project which started with an assessment of needs and resources in the community, the science topics for the urban project were identified based on existing course guides. The urban materials did not undergo small-scale tryout but were used at once by the target groups. In terms of evaluation procedures, they are basically the same. Evaluation instruments used are questionnaires, written and performance tests, verbal and non-verbal reactions of students, feedbacks from teachers and parents.

Innovations in teacher education

Each of these programmes was designed to meet a particular local need. The dearth of qualified physics and mathematics teachers was behind the launching of the Bachelor of Science in Mathematics Teaching (BSMT) and Bachelor of Science in Physics Teaching (BSPT) programmes.

The lack of trained secondary school teachers in rural high-schools led to the Bachelor of Science in Elementary and Secondary Education (BSESE) programme which aims to equip teachers with the necessary competencies for handling both the elementary and secondary levels of schooling, thus enabling elementary school teachers to be utilized in the Barangay high schools.

The problem of having good technicians who can at the same time be good teachers of industrial arts was behind the programme of the Technical University of the Philippines (TUP) for the preparation of vocational/industrial teachers.

The need to upgrade the science and mathematics background of Muslim teachers in the predominantly Muslim areas and other ethnic communities in Mindanao is the rationale for the EAMA project of the Notre Dame of Marbel College.

The dearth of teacher's materials on environmental studies utilizing Philippine situations, data and information, promoted the UPSEC to develop a series of materials on this topic.

Linking science education to real life

The programme were addressed to a variety of clientele, namely:

1. teacher scholars (gifted) recruited to meet the need for strong physics/mathematics teachers in the secondary schools;
2. undergraduates of teacher-training programme who may be assigned to an elementary and/or secondary schools;
3. science teachers who need a richer content background in environmental science;
4. vocational/industrial arts teachers; and
5. teachers from communities where more effective teaching as well as teacher training is hampered by cultural mores and traditions.

The outstanding features of the innovative programme are the following:

1. Exposure of prospective and practicing teachers to the communities they are to serve.

This approach is intended to sensitize the teachers to the cultural, social and environmental needs of these communities. For example, students of BSMT and BSPT had to undergo apprenticeship in the Regional Science Teaching Centres (RSTC) during the summer institutes, while in the Educational Association for Muslim Areas (EAMA) 18-month course on science education on the masteral level, the students had to undertake periodic visits to an elementary school in a predominantly Muslim area.

2. Modification of the regular curriculum to make it more responsive to the needs of the students.

In the curriculum of the EAMA project, cultural studies were incorporated and an interdisciplinary approach to the teaching of science was used for which teaching materials, specifically for the Muslim participants, were developed. To prepare industrial/vocational teachers at TUP, work orientation is focused on the instructional activities, e.g. devices/actual machines are developed from which students can acquire manipulative skills. In the BSMT and BSPT programme, there was reduction of professional education courses to accommodate inclusion of more physics/mathematics subjects in such a way that the curriculum is as rich as any regular Bachelor of Science course.

3. Deriving content of curriculum materials from primary sources in the country not normally tapped by teachers for classroom teaching.

The teacher resource materials on Philippine environmental studies of UPSEC secure the most recent findings on the Philippine biophysical and socio-cultural conditions from government agencies, industries and private institutions. These materials are intended to develop teachers' awareness of existing environmental problems so that they can, in turn, transfer this awareness to their students.

There was an observable variety of problems concerning various aspects/factors, for example:

1. the clientele

   a) lack of interest in the science teaching profession among BSMT/BSPT scholars, as well as among practicing teachers;

   b) indifference of teachers towards in-service training activities; and

   c) lack of the desired clientele in certain teacher-education courses, e.g., male students in vocational/industrial arts courses;

2. the administrative aspect

   a) getting the "wrong" clientele for training activities because of extraneous factors during the selection process;

   b) ineffective implementation of innovative programmes by trained teachers in the local level, e.g. non-utilization of trained science teachers to bring about a multiplier effect; and

   c) innovative enrichment materials kept in the cloistered recesses of the library or on the display shelf of the principal.

3. the training programmes/materials

   a) the use of science training as a qualification for promotion to an administrative task; and

   b) teachers' dependence on sophisticated equipment and/or written curricular materials in actual teaching.

From all these observations, one could infer that teacher education is a rich field for educational innovation.

Innovations establishing linkages between rural development projects and curriculum development

The projects reported in this section are concerned with the education not only of children in the formal setting but of every member of the rural community. Because of the complex nature of community needs, linkages have been established with government agencies and private institutions engaged in community development, and with scientists and other individuals who can provide the necessary expertise. Areas covered are closely linked with the environment: health, nutrition, sanitation, economic alternatives based on existing resources, ecology and conservation. Skills for increasing their economic productivity have a great appeal to the rural folks and are on top of their priority listing of perceived needs.

The UPSEC science project in upland communities is aimed at producing reading materials and introducing activities on the proper use and management of the forest to maintain a healthy and stable environment. Massive destruction of Philippine forests is a major problem, resulting from the activities of individuals or large economic concerns. This project, based in two villages on the foothills of Sierra Madre ranges and Mt. Banahaw is a small attempt to create environmental awareness in the rural folk whose source of livelihood is the forest.

The San Salvador Project, on the other hand, is geared towards the improvement of the quality of life in a depressed, isolated fishing village through rural education. Seminars and workshops were conducted on topics directly related to fishing and environmental sanitation. Integrated science and technology modules have also been written for school children, adults and out-of-school youth. Most of the materials are intended for the non-formal setting but some of these can also be used inside the classrooms. A number of modules have been written mainly for formal classes.

Input of experts in various fields was sought at various stages of the projects. Entry point were the schools with permission and support of the Ministry of Education and Culture. A medical doctor was requested to hold a free clinic for the upland project; this occasion was used for obtaining family data in the villages. Seminars and projects were conducted by researchers and scientists from various government agencies, educational institutions and private corporations who are involved in rural development. Some moduels were written by them or in constant consultation with them.

It has been observed that increased relevance of learning modules for the formal setting is achieved, as a result of a thorough study of the needs, resources, beliefs and practices of the community. But learning acquired in the classroom will be more

meaningful if concepts learned can be applied and observed in the home and in the community where these children spend a greater part of the day. This is the rationale behind the two projects from the viewpoint of science education.

The fisheries school project in Apacabile Batangas presents an effort to make the science courses more relevant and directly geared to fishery education. There is utilization of external expertise and support. New techniques are indirectly tested through the extension services rendered by the school for the community.

The Demersal fisheries study is basically a research project conducted in the field (Samar Sea and environs) with built-in training component for students and fishermen. Its goal is to attain increased fish production. Data gathered in the research can serve as bases for promulgation of regulations in the fishing industry. The methodology consists of: (a) determining existing resources in Samar Sea; (b) improving present fishing methods; (c) test fishing with innovative fishing gears; and (d) training on fishing technology; fish handling, oceanography, and navigation. Students and fishermen are members of the research team who undergo on-the-job training in research methodology, operation of fishing boats and other aspects of marine fisheries. In addition, workshops on various aspects of hydrobiological research have been conducted for staff of the local colleges of fisheries. Training on fishing technology, fish handling, oceanography has also been made available to a selected group coming from the public and private sectors.

Summing up acrosss the four groups of innovations, we can identify the unifying threads weaving through the innovations. The more prominent ones are the following:

- the unobtrusive integration of formal and non-formal education aspects in the projects;
- the trend to make learning relevant to life through active involvement of the community in the developmental stages of innovative programmes;
- a serious attempt to base the selection of content for both curriculum development and teacher education on needs assessment of the community/target users to make the programme more relevant to real needs of the clientele;
- the trend to use teachers in non-traditional roles e.g. direct involvement in the solution of community problems, curriculum material development, improvement of instructional aids, and the management of innovative programme for both formal and non-formal settings;

- the trend to develop and utilize self-instructional materials and activity experiences as instruments for promoting learning for both in-school and out-of-school populations; and
- the need for innovation in teacher education which surfaced upon analysis of various curriculum development projects; new skills and methodologies are required of teachers for handling innovative approaches to education.

All the projects presented in the seminar-workshop are laudable efforts for they contribute to the national government's goal of promoting and realizing a better life for all its people through a better type of science technology education. The innovative projects provide effective ways towards meeting the development needs of the communities and the country as a whole.

SOCIALIST REPUBLIC OF VIET NAM

The National Workshop on Linking Science Education to Real-life Experiences was organized in Hanoi, Socialist Republic of Viet-Nam, from 25 to 30 November 1979. A total number of 35 participants comprising officers from the various divisions of the Ministry of Education as well as lectures from Teachers' Training College of Hanoi, principals and teachers of advanced schools participated in this Workshop.

After much deliberations and discussions the participants of the National Workshop came up with the following observations:

The 1979 Decision on Education Reform of the Socialist Republic of Viet Nam made clear the significance and role of linking education to life and placed it within the framework of a more comprehensive principle i.e. "Study must go together with practice, education must be combined with production and the school must be linked to society."

Under the "Training Project for Basic Education" schools made preparation for the forthcoming educational reform. Currently the time allocated for various activities of students is as follows:

- study time: 77.5% of the school time is devoted to educational activities;
- productive labour: 9%
- social activities and communal activities: 9%
- extra-mural activities: 4.5%

Concrete measures

In order to link educational experiences to real-life situations and needs of the society, a number of steps have been taken in terms of curriculum objectives, methods of teaching and training of teachers. The following are some of the examples of actions taken and need for further action.

To link education to life, the curriculum should meet the following requirements:

1. Early introduction of scientific theory, which alone can streamline the content of the instruction, encompass scattered scientific facts and explain reality correctly. For example, some rudiments of the theory of atomic structure can be taught even at the basic courses of physics and chemistry.

2. Knowledge on methods like the experimental method, structural method, etc., can be imparted at an early stage to develop in the pupil the capacity to generalize from his experience of life and draw scientific conclusions to be applied to practice.

3. Apart from general knowledge, some amount of time is devoted to the teaching of knowledge about the locality of each school, district primary and elementary schools and the secondary schools of the province. The Bac Ly institution for example has prepared and incorporated in its syllabuses lessons on:

- the natural and economic geography of the Ha Nam Ninh province and Ly Nhan district (topography, climate, hydrography, communications, fauna and flora);
- the flora of the Red River alluvial bank;
- the duck-eggs hatching and spawn-collecting and breeding trades of Bac Ly village;
- the improved farming implements used in summer-rice low-level land;
- local medicinal herbs and treatment of diseases using them;
- sugar-cane and jute growing on land reclaimed from the Red River.

4. Practical experiences for the pupil need to be organized in the natural environment and the needs of the society should be closely linked to the activities. These should contribute to the transformation of nature, society and man. Only in this way, can the school train pupils capable of meeting the requirements of the society. For example in the rural locations, pupils are made to co-operate with members of farming co-operatives and local technicians

in jobs such as seed and strain selection, breeding of azolla strains, supplementary pollination for maize plants, manuring of rice plants, processing animal fodder, spraying of insecticides, planning of hydraulic works, analysing each kind of soil with a view to delimiting crop areas and improvement of its fertility.

5. Participation in investigations carried out by local co-operatives and scientific institutions is of a great pedagogical and practical value and helps to enhance the school's credit with society. The themes of the research could centre around the following:

- conditions and methods of raising various species of plants and animals;
- cross-breeding plants and animals for strain-improving purposes;
- classification of soil, delimiting of crop areas; and
- use and improvement of instruments of production

6. Stepping up of extra-mural activities by visits to production centres and other collective activities are to be increased, as interesting and entertaining forms of scientific information and experience could be derived (fish 'fanciers', bird 'fanciers' and plant 'fanciers' associations).

7. Qualified teachers are required for the task of linking science education and real life. The training programme should be so designed as to make teachers fully realize the importance of their task, and master the content and method in order to effectively organize teaching and learning activities.

8. A recent innovation is the establishment of a contingent of 'teachers of technique' to make good the shortage of teachers of technical subjects. Teachers already having a job are given an extra one, after some period of additional instruction. For example, a teacher of physics can also teach technical electricity, or a teacher of biology can assume concurrently the task of teaching farming techniques on condition that gradually these dual teachers will only specialize in their main subjects, which will facilitate their further training and remuneration.

9. Auxiliary teachers have been recruited from amongst research workers, engineers, technicians of various branches in the locality to teach techniques and supervise pupil practice work like driving a tractor or cultivating experimental fields.

10. Teachers have been provided with facilities to carry out experiments and research, thereby improving their knowledge, skills and capacity for practical activities. This is regarded as one of

the most important measures to continuously improve teachers' standards in the context of the extraordinary rate of development of modern science and technology and in keeping with the realities of each locality.

11. Setting up of school laboratories, whose network will be gradually changed into one of specialized laboratories attached to each section such as: building of school gardens; use of public facilities; and manufacturing of simple and low-cost teaching aids.

Great importance is attached to the manufacturing of simple low-cost teaching aids because of their economic and educational significance. In recent years (1971, 1976 and 1978) competitions have been organized in teaching aid making. In the one held in Ho Chi Minh in 1978, there were about 1000 items entered, of which 380 won prizes.

SRI LANKA

The programmes presented at this Workshop encompass a wide range of educational activities. In line with the objectives of the Workshop, the programme was designed so as to give it an interdisciplinary and interdepartmental character. Nine on-going projects which mainly attempt to link science learning to real-life situations were discussed in three groups to determine the effectiveness of the approaches used in these projects and to effect further improvements in terms of the developed strategies which are to be recommended for wider use.

The primary integrated curriculum programme is a nation-wide one. Nine thousand of Sri Lanka's schools have adopted this programme. The presentation focuses how a well thought out national programme, even at the primary level, provides opportunities for pupils and teachers to take part in an innovative activity. The three Curriculum Development Centre (CDC) projects on inclusion of non-traditional areas of study in the advanced-level curriculum is an example of an innovation in curriculum development. National level experts and field personnel have been given a chance to work together with curriculum developers and classroom teachers through these projects. This approach to curriculum development had its genesis during the late fifties. Experience has shown that teacher-directed science curriculum development is poor as far as the content is concerned. It is out of date and lacking the insights of the scientists who are working at the frontiers of scientific activity. Similarly, science curricula developed by scientists alone is also poor from a pedagogical point of view. The approach adopted in the CDC projects allows the best aspects of both outlooks to be combined. Also this experiment highlights the need for an institutional infrastructure such as a CDC to act as an intermediary

organization as well as a catalytic force to continuously update the curriculum to respond to changing national development needs and aspirations.

The projects of the Thondaimanaru Centre indicate the value of a field-work oriented organization. It has provided the aegis for pupils, teachers, curriculum developers, field personnel, engineers and scientists to come together to discuss environmental problems and identify study programmes. The organization of the centre and its history of development is noteworthy. The need for the participation of many persons for a hydro-biological survey gave the opportunity for a devoted band of teachers to form an association for scientific investigative activity.

The Kurulukele and Kaluganga River Bank Field Study Centres emphasize the field resources aspect as a generator of science learning activities. The resources are respectively, a forest and bird sanctuary and a fertile riverine habitat. These resources are utilized in a planned way for regular science field studies. The spin offs are science museums and science monographs.

The Pinnawala school experiment indicates what resourceful teachers can do even within the confines of a given curriculum. It is a bold experiment because the astronomy taught with emphasis on historical development of the scientific thought is not a requirement of the syllabus. What it acheives for the school as a whole is itself noteworthy.

These centres have given the students a first hand opportunity to participate in basic observational and investigative studies. The science they learn will enable them to utilize the knowledge for the enrichment of their lives and their environment, a thing which sterile class textbooks are unable to achieve.

The projects

The Sri Lanka projects and programmes presented at the National Workshop were chosen to indicate a wide array of attempts made to link science learning with real-life. Documentation regarding these projects were prepared at the national workshop and presented separatley in booklet form at the sub-regional workshop. Some photographic slides depicting aspects of some of the projects were also presented.

1. Kurulukele Field Studies Centre Programme at Kegalle

This project makes use of a forest as a resource for science teaching. As the name implies, it is also a bird sanctuary. The forest itself is situated in a district town, 80 kilometres from Colombo and adjoints two large secondary schools teaching science.

The plan to develop this resource as a science studies centre started as a senior secondary school project of Kegalu Maha Vidyalaya Secondary School, under the Senior Secondary Project Work Programme. In August 1979 this resource was adopted as a Ministry of Education Field Studies Centre. Since then the forest trails have been further developed, study stations identified, a museum started and study camps organized as a part of a regular programme. Within a course of a year, a complete centre with buildings and furniture will be organized, so that the resource will be available for a wider and deeper study.

2. The Field Studies Programme concerning the Kaluganga River Bank at Horana

This centre is also to serve as a Ministry of Education directed Field Studies Centre like Kurulukele with a river-bank environment as the resource. The river bank site is about 40 kilometres from Colombo. Two schools in a nearby town and a small school form the organizational nucleus for this field studies centre. The centre museum will be at one of the schools and during camps, on-site tent accommodation will be provided. The main area of studies will be the river, the river bank, flora and fauna, as well as aspects of water pollution and effects of frequent flooding.

3. Primary Science Programme

An integrated curriculum was introduced in the primary schools beginning Grade I in 1974. The elements of empirical science and training in scientific experimentation such as control of variables find a place in this curriculum. The integrated curriculum was built around eleven themes, which concern the child's experiential environment. The philosophy was one of understanding through activity, and the approach was process-oriented. The new curriculum gave opportunities for the child to study at his own pace, to experiment, to learn through manipulation of objects and the environment, to make observations and report on them, to make judgements etc.

4. The Hydro-biological Survey Programme of the Thondaimanaru Field Work Centre

This programme aimed at the development of the Jaffna Peninsula (Northern part of the island) and hence, the programme was of interest to the whole community. It exposed them to the problems concerning underground water that are vital to the people of Jaffna. Developed at three levels, for youth, teachers and the community as a whole, this programme has emerged as one with the inter-dependent objectives of research, science and development.

5. Monitoring of Pollution Project at the Thondaimanaru Field Work Centre

The Field Work Centre supports formal education by organizing enrichment programmes in science, aesthetics, technical subjects and languages. One such programme presented at this Workshop shows a novel attempt of developing material on "Pollution" for use at the Senior Secondary Level. Here pupils, teachers and experts joined together in developing the materials, while the trial of the materials on the target population was built into the development of the materials.

6. Introduction of information regarding the resources of Sri Lanka into the Advanced-level (Grades XI and XII) Science curriculum as a non-traditional area of study - Curriculum Development Centre Project

In designing the new G.C.E. Advanced Level Chemistry curriculum, a deliberate attempt was made to make the chemistry learnt at school relevant to the every day needs of children. With this end in view a number of non-traditional areas were included in the syllabus. One important area deals with the natural resources of Sri Lanka. As the teachers are not familiar with this area, a national workshop was conducted with Unesco assistance to prepare background resource materials on topics related to this area. At the workshop a group drawn from experienced advanced level teachers, training college lecturers, science circuit education officers and officers from the Curriculum Development Centre functioned as the writing teams. They were guided by consultants drawn from a number of specialized agencies.

7. Introduction of information regarding Pests and Pest Control into the Advanced Level Science Curriculum as a non-traditional area of study - a Curriculum Development Centre Project

Field supervisors and research personnel were brought together to produce the background information material for this non-traditional topic for the zoology teachers who have long been following a curriculum based on the requirements of the 20% university entrants of the senior secondary level.

8. Introduction of information regarding Fisheries into the advanced level science curriculum as a non-traditional area of study - a Curriculum Development Centre Project

Another parallel workshop was run on lines similar to inland fisheries to produce the background material in another area of national priority. This background material gives fundamental knowledge and insight into some of the modern technology associated with culturing of fish as a home-based industry.

9. Introduction of science through astronomy - an innovative project done by a village secondary school - Pinnawala Maha Vidyalaya - Rambukkana

This is an experiment done by a rural school about 90 kilometres from Colombo. In one way this forms a complete curriculum unit in astronomy with both the theoretical and practical aspects fully covered. Although it has its intrinsic value as an introduction to an important branch of science, this aspect is treated as incidental. The prupose is to find an interesting as well as an effective means of introducing science to pupils in grades 9 and 11 with different entry attainment levels in science. The basic observations using simple telescopes and home made star maps help pupils to build tentative models of the universe to fit observed facts. A model is elaborated as more data is gathered. When unexpected observations such as the apparent retrograde motion of planets are recorded, the simple model is stretched to absurd limits. Then the Copernican heliocentric model comes in handy. It comes as an illuminating discovery. The pupils are made to go through centuries of development of ideas from Plato to Newton through Copernicus and Kepler in a very short observation-oriented course. The stages of scientific method, observation, hypothesis building, testing hypothesis, discarding of hypothesis in the face of empirical evidence is thus given. Above all, the laws of motion - the pillars of physics are shown to have a heavenly origin - as it historically was.

THAILAND

The National Workshop was organized by the Institute for the Promotion of Teaching Science and Technology (JPST) from 19 to 23 November 1979. The workshop confined its scope to only one project in order to conduct an effective work under certain limitations. The high school biology curriculum was selected for this purpose.

Thirty participants comprising high school biology teachers, college and university instructors, representatives from the Ministry of Education, and 24 invited specialists from government agencies and organizations such as Department of Agriculture, Medical Health Department, took part in the workshop. Ideas and information concerning aspects which should be considered in the improvement of the biology curriculum so as to link it to real-life situations of the country were presented and discussed. The various aspects included agriculture, medical science, health and public welfare, national resources, population and nutrition. Ideas about training programmes for biology teachers, both pre-service and in-service, were also discussed.

Linking science education to real life

Ideas and information obtained during the discussions included issues concerning the course content, teaching methods, teaching aids and others pertaining to not only the high school biology curriculum but also to the development and implementation of other school science curricula.

Data presented by experts pertaining to the causes of death of Thai people was an example of a real-life situation which should be a concern of the biology curriculum. From this situation, suggestions were made such as: students should be made aware of the necessity, side-effects and other essential understanding concerning vaccination and disease carrier control. These are examples of issues concerning the course content.

Problems in teaching some topics in biology that relate to real-life situations were recognized, and some interesting techniques were also suggested. In teaching conservation of natural resources, the suggested strategy began with the pointing out of harmful effects of resources destruction. Causes of resource destruction were identified leading to discussion of the procedures in conservation. It was also suggested that students should be given learning experiences concerning the relationship among resources and how to utilize them effectively. This is an example of a suggested teaching strategy. It was further suggested that teachers must be trained to gain basic understanding and up-to-date information on natural resources, conservation and utilization through first-hand experiences concerning these aspects. Effective audio-visual aids must be designed, produced and distributed for wider use. There are suggestions on other issues concerning the development and implementation of the science curriculum programmes linked to real-life situations.

The participants also recognized factors that influence the implementations of the curriculum to be developed. Thus, some recommendations were made for successful curriculum implementation. The three major recommendations were: i) the development of evaluation instruments and procedures should be carried out in order to know whether or not the intended learning has taken place, and to ensure that the teaching and learning activities conducted in the actual classroom are in harmony with the curriculum objectives being set; ii) the training programmes for prospective science teachers should be strengthened to produce better qualified teachers; and iii) a local science centre should be established to provide additional experiences and competencies necessary for teachers, collect and provide data and information which are very much useful in the development of instructional materials, and other related purposes.

CHAPTER III

SUGGESTIONS FOR DESIGNING, DEVELOPING AND IMPLEMENTING SCIENCE CURRICULA TO LINK THEM WITH REAL-LIFE SITUATIONS AND IMPLICATIONS FOR TEACHER TRAINING

During the last decade, considerable efforts have been made in all the participating countries of this region to bring about qualitative improvements in science education at all levels of schooling. The content and methodology of science and technology education have been changed and new methodologies have been developed in curriculum designing, curriculum development and curriculum implementation.

Though there have been many successes, one finds that not enough attention has been paid to the applications to daily life of the science learnt at the school. There is however more recognition that science learning, particularly at the first level of education, should be child centred and activity based. Inspite of this, one finds a traditional approach of teaching science as a body of facts is prevalent at all levels of education and there continues to be an emphasis on rote-learning of science, with more concern for pure science principles first and foremost.

Almost all the countries represented in the Workshop have developed institutional infrastructures to undertake curriculum development work. This has been seen as a major strength in accelerating curriculum reforms, particularly in the area of science education.

Though there has been considerable progress made in curriculum development activity, one finds that the teacher training programmes, particularly the pre-service training programmes have not kept pace with the needs of the new curriculum. In order that science education can make a meaningful contribution towards the national development efforts and becomes more relevant by linking it with real-life problems and environment, additional competencies are needed for the teachers to play their new role as they are not to be seen only as one "imparting instructions" but as a guide and helper to the child, as indentifier of real-life problems, community expertise and other resources and one who is fully familiar with the environment and the natural resources available in the nearby area. Teacher training programmes therefore need to be critically analysed and restructured to provide for experiences which will help develop these competencies.

Linking science education to real life

Based on the discussions of the experiences collected during the national workshops, their analysis and participants personal experiences, the Workshop decided that as the aims of science teaching-learning and the emphasis that it needs at various levels of education are different, the guidelines be developed separately for the normally accepted three levels of school education - primary, secondary, and upper secondary.

Primary-level science education

Recent trends at the primary level are showing a major shift in a number of countries from factual learning of science to processes and methodology of science and its linkages with environment - physical, natural, social - and real-life problems. Arising out of this, more and more curricula are moving towards a unified or integrated approach to the content within the various branches of science. In some cases the integration has gone even beyond the boundaries of the disciplines of science to other areas of curriculum such as social studies and humanities. Attempts are also being made to decentralize the curriculum development activity within the broad framework of a centrally developed curriculum, allowing for opportunities to bring local specific real-life situations into the curriculum.

Curriculum design considerations

1. The broadly accepted aims of science education for this level of education are not discussed here but it is suggested that creating an awareness of the environment-physical, natural and social - should be the main aim. This will include, among others, giving the pupils an idea that:

   a) human beings are a part of the environment;

   b) the environment affects our lives;

   c) it is possible to find out the principles governing the environment;

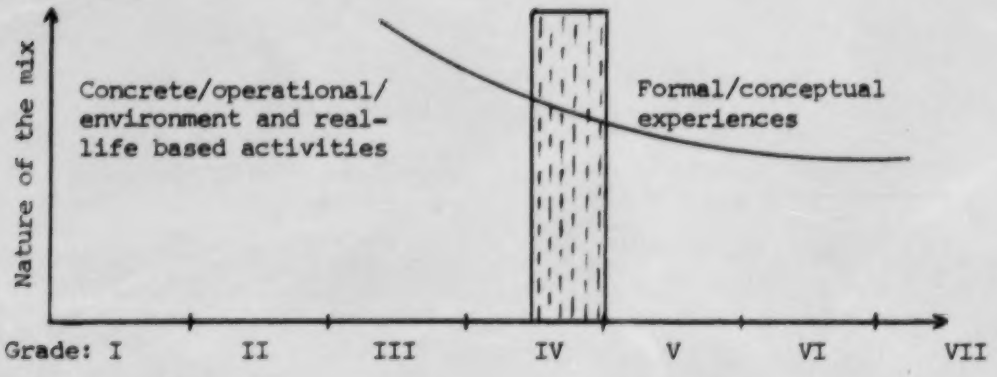
   d) various aspects of the environment are inter-related and changing one can change many others; and

   e) our actions can cause the environment to become inimical and using our knowledge we can sometimes make the environment more helpful to us.

Science at this level need not necessarily be a separate subject in the curriculum, but good science knowledge could be infused into a common or integrated curriculum through the provision of appropriate science based learning experiences and by the inclusion of different science processes and its methodology.

2. The first consideration in the curriculum design at this stage should be the developmental stages of the child. The child enters the first level of education with mental processes largely in the concrete operations stage and having the need to master many psychomotor skills. Learning at the early stages could therefore largely be provided through manipulative activity. Here science has advantage over other disciplines because of its basic empirical nature and philosophy. Activity based work can be the basis of introducing children to the world of science as young pupils have very perceptive observation skills. How advantage can be taken of the pupils mental development from concrete to formal operation stage in the provision of science experiences at this level of education can be illustrated by the following diagram which indicates the progressive increasing of the formal and conceptual elements in the concrete and formal/conceptual operations mix.

The diagram below attempts to present a possible arrangement of the mix.



The transect of the graph of a column appropriate to the age indicates an idea ofthe ratio of the mix between concrete and formal/conceptual experiences in science.

This is only a diagramatic representation indicating progressive variation of the ratio with a great deal of variation possible depending on the nature of the science experiences.

What is important is that more attention should be given at the early stages to "provide science experiences" from the environment and real-life situations, rather than attempt to "teach science" as facts and concepts. Gradually the observation and study of environment and real-life situations could be used for development of concepts and progressively the emphasis should shift to conceptual understanding, but at the same time not neglecting the study of environment and real-life problems.

3. Another design consideration is the mix regarding cognitive, affective and psychomotor elements in the planning of experiences. Here too, the nature of the mix could depend largely on the experiences provided. It is necessary to avoid giving over simplified and thus at times incorrect unnecessary cognitive elements so that this may not become a hindrance to the pupils when they undertake science studies later in life. It is a good strategy to provide for cognitive elements in an incidental way through observation and manipulation. This will also help in encouraging pupils in divergent thinking and making their own concepts. The young age of the pupil makes it easy to concentrate at this stage on affective domain aspects. Pupils at this level of schooling are just forming their attitudes which will continue to affect their world-view later in life. The scientific way of hypothesis formation, hypothesis testing, hypothesis discarding can be inculcated through programmes such as are being used in the Sri Lanka primary education. The principle of validation of a hypothesis or hunch through experimentation which characterizes the very nature of science is a valuable experience for building desirable attitudes. Thus the pupil will be trained to view experimental evidence as significant in the face of argumentative theses. The affective component involved in learning while working in real life situations, as in Viet Nam, is also worthy of notice. Special care is also needed to foster the affective component regarding attitudes towards the environment, nutrition, love of nature as indicated in the Japan programme.

4. The issue of utilizing the structure of the discipline versus available real-life situations as a starting point for identifying the science experiences is also a design consideration.

In view of the fact that children would be exposed to guided and organized science experiences for the first time at this level of education, and also keeping in view the considerations enumerated in the sections above, it appears desirable at this first level of basic education, to provide children with concrete experiences and equip them with psychomotor skills without much emphasis on science content. As the child progresses through the grades, real-life situations based on science can be used as starting points from which tasks can be identified falling under the three domains; psychomotor, cognitive and affective, so that he can also acquire some science concepts within his level of cognitive development that he can apply to daily life.

Considering the need for preparation of pupils for science studies later, a judicious combination of both aspects is also advocated.

Whether real-life experiences should be given through selected organized experiences as classroom activities or through unprogrammed exposure to a complex real-life situation as in Viet-Nam is a moot point.

5. The selection of classroom science activities is an important design consideration. While use of materials available in home and neighbourhood will encourage pupils to continue the experimentation at home, the use of appropriate scientific equipment should not be excluded wherever such improvisations are not feasible. For instance it is not possible to use an improvised simple air thermometer for measuring temperatures. Wherever possible 'black box' equipment needs to be avoided so as not to give the child the idea that science has a magic element. Design of experiments for classroom use should take into account the need for fewer outcomes so that the child is not confused with his discovery or findings. Where a number of outcomes are unavoidable, the main and meaningful outcomes have to be made prominent. The design of the experiments must take into account the need for them to be interesting so as to sustain the pupils interest.

However, as a major guiding principle, the use of local environment, and locally available materials and resources should guide the developing of science learning experiences.

6. The inclusion of elements of interest to the community such as those concerning health and nutrition, agriculture, fisheries, more economical utilization of fuel will be advantageous for several reasons. Being real-life concerns, these elements will ensure that education at this level has a real-life base. In addition, these elements have a 'take-home value'. The pupils will relate to the parents things discussed at school when they are concerns of the home too. This has the effect of extending the reach of the school to the home and eventually to the community. This strategy, it is felt, will work in several of the countries of the region because:

a) the majority of pupils now in primary schools are in the first generation of those being exposed to science experiences on a wide scale. (The parents, even if they have had an education, probably would not have been exposed to such experiences).

b) the pupils might be the first generation ever being given a school education on a wide scale. The parents look up to their children to utilize school education as a means of liberating the whole family from poverty and drudgery. Therefore, the parents will be prepared to learn from their children new concepts.

7. The first level of education is perhaps the only level where universal education is possible in most of the countries of the region. Curriculum reform, however desirable, is expensive and from a logistics point of view sometimes non-implementable. One has to consider the risk of a long period of non-action between the time when the reformed curriculum becomes fully operative and the demise

of the old curriculum. Here an evolutionary change appears to be preferable to a radical change. Pilot trials themselves are not very reliable. Therefore, it is best to build into the curriculum organization self-correcting features. Here, we may adopt a cybernetic model with feed back loops from the field affecting the curriculum organization and with points where new inputs could be fed in. A formative programme evaluation element has also to be built into the curriculum design (organization) so that curriculum development becomes a continuing refinement activity on the one hand and assimilation of new ideas and trends on the other. The latter aspect also involves rejection of obsolete material on a continuing basis.

8. The provision of real-life experiences to pupils need not be limited by the lack of certain areas of expertise among school teachers. The teachers have to be oriented to look at extra school personnel resources as utilizable. The use of community personnel, such as that of the auxiliary teacher scheme in Viet-Nam needs mention here. Indeed the habit of looking for all expertise within the education sub-system should be eliminated.

9. In order that design considerations such as given above are deliberated upon before embarking on a curriculum development, an institutional infrastructure is needed. Curriculum development undertaken on an ad hoc basis and in fits and starts would best be a patch-work attempt.

Curriculum development

The development of curriculum materials that are environment-based and linked to real-life situations requires newer dimensions and strategies that veer away from conventional modes of curriculum preparation. The key role of the teacher and community experts in the process of curriculum development calls for well-defined and easy-to-manage steps. This principle of simplicity is crucial in the promotion of indigenous curriculum development.

The following suggestions include the steps in the preparation of the materials and the corresponding basic considerations which could help making science learning more relevant to the child's real-life needs and problems.

1. Assessment of needs

   a) In terms of national development goals, identify the needs of the community.

   b) Establish a priority of the identified needs.

Strategies which could be used for the assessment of needs:

a) Survey of needs and problems in the community.

b) Study of available documents and research previously conducted on community needs and problems.

c) Involvement of available experts such as educators, scientists, craftsmen and other community workers in the identification and prioritizing needs.

d) Survey of resources in the community.

2. Selection of topic/content

a) Select the content on the basis of:

i) the identified significant needs

ii) the national development goals

iii) the minimum learning needs and/or the educational objective for the particular grade level

b) Consider the following in the selection of content:

i) the student's mental maturity, interest and readiness

ii) the time allocation for the material to be developed

iii) the learning environment which will include teaching facilities and equipment and the teacher

iv) the available resources in the community

v) the utility value of the content in improving the life in the community

c) List down all potential topics that may be covered.

d) Decide on the topics to be covered.

e) Determine the particular grade level for which the material is to be prepared.

f) Develop a sequence of the selected topics with consideration of:

i) the role of each topic in solving a problem or meeting the community need

ii) the prerequisite concepts in learning each topic

Linking science education to real life

Strategies which could be used for the selection of topic/content:

a) Study of real-life situations from which science concepts and principles for the content of the curriculum material may be derived.

b) Analysis of available curriculum materials from which related content may be selected for inclusion in the material to be developed.

c) Use of an integrated approach in determining the cluster of content for the curriculum material.

d) Submission of selected content to curriculum experts, science specialists and the community for comments and suggestions.

3. Selection of teaching/learning strategies

a) Develop methodologies with consideration of:

i) the capabilities of the target users, e.g. aptitude, cognitive and psychomotor skills of learners

ii) the availability of local resources for carrying out the activities (material, human, financial, natural)

iii) the knowledge background and attitude of the teacher or trainer who will implement the curriculum

iv) the cultural values and aspirations of people in the community

b) Formulate instructional objectives that are operational and written in simple language and style.

c) Consider the following alternatives in the selection and/or development of instructional strategies.

i) Exploration of real-life situations in the community in the identification of learning activities.

ii) Provision for first-hand experiences that are activity-oriented, child centred and environment-based.

iii) Utilization of available resources to the full, e.g. use of ready-made laboratory equipment and facilities supplemented by resources in the environment.

iv) Use of self-instructional materials such as picture books, worksheets, activity guides, in the study of the environment.

v) Provision for formative evaluation in terms of the objectives in the learning experience.

vi) Development of basic science skills appropriate for the grade level.

d) Involve experienced science and technology teachers, specialists, psychologists, and other experts in the selection and/or development of instructional strategies.

e) Tryout the selected methodologies to determine their appropriateness and workability.

4. Development of the curriculum material

a) Decide on the format of the material with the following considerations:

i) The target user of the material (his mental ability, interest, readiness).

ii) Provision for effecting purposeful learning, e.g. should be motivational to include a variety of approaches such as investigative activities, games, puzzles, pictorial presentations, stories.

iii) Provision for clear directions on how to use the material.

iv) Provision for well-defined steps in the use of the learning strategies.

v) Provision for flexibility in the use of suggested materials and strategies.

vi) Provision for the selection, purchase and/or improvisation of instructional aids.

b) Decide on the type of curriculum material to prepare (self-learning materials, teacher's guide, information/worksheets) on the basis of:

i) the objectives of the project

ii) the selected content

iii) the selected strategies

c) Prepare/write the curriculum material.

i) Formulate the instructional objectives.

ii) Describe the activities that will achieve the objectives.

iii) Indicate the materials/media to use in the instructional activities.

iv) Develop evaluation strategies in relation to the objectives.

v) Provide for enrichment, supplementary and/or remedial activities.

5. Tryout and evaluation of the developed curriculum material

Determining the effectiveness of an innovative material requires a careful and systematic scheme of try-out. The following considerations should be borne in mind:

a) Decide on the coverage of the try-out: micro-scale, involving one or two schools/classes/groups or macro-scale, involving a wide sampling of students.

b) Decide on the duration of the try-out.

c) Plan the orientation programme required for the try out.

d) Develop evaluation instruments to determine the effectiveness of the material such as: questionnaires, reaction sheets, test instruments for pupils, competency measures, attitude scales, etc.

e) Prepare a scheme for the retrieval, consolidation and analysis of the feedback data.

f) Enjoin the participation of curriculum experts and specialists in the evaluation of the materials and the try-out data.

6. Revision of the try-out material

a) Improvement of the material should be based on the results of its try out and on the perceptions of curriculum experts and subject specialists, as well as of community laymen and teachers who have participated in the try-out.

b) Revision of the material may be done by the individual writer or group of writers considering salient feedback and comments and recommendations of experts, teachers and community laymen.

7. Printing of the innovative material

a) The material should clearly illustrate the intent of its innovative features.

b) There should be considerations of cost in terms of money, time and effort in the material production.

Curriculum implementation

Available information about curriculum development efforts in the participating Member States indicates that the implementation aspect is wanting in terms of:

- continuing and adequate support
- linkage and co-ordination with teacher education, material production, and instructional and management systems
- mobilization of needed resources

The implementation of an innovative science curriculum such as one linked to real-life experiences would require clearer directions and strategies that are manageable, comprehensive and flexible enough to apply to varying situations. The following guidelines relate to the role of main components of the implementation mechanism: teachers, management, parents, and the community.

1. Teachers

The teacher's role in the implementation of a curriculum which attempts to link science learning to real-life situations, demands competencies and attitudes that to a great extent will determine the success or failure of the undertaking. These include:

- sensitivity to the felt needs of students and the community
- openness to change and criticism
- commitment to improve science teaching geared to particular culture and values
- skills in interpersonal relationships
- willingness to improve/update science knowledge and competencies by reading scientific literature, attending lectures/workshops on science education
- ability to introduce and carry out change in science teaching

- ability to identify relevant science content from events and activities in the environment and relate them to classroom activities
- ability to utilize everyday/real-life situation as spring board for introducing science and technology content
- ability to locate and use local resources, human and material, for instructional purposes and project implementation
- skill and ability in designing and constructing low-cost equipment and aids for instruction
- programme and classroom management skills
- skills in conducting out-of-classroom activities such as field studies, field trips and community-related projects
- critical/analytical/creative thinking
- sufficient knowledge of the immediate natural environment and community of the child. (Environment - land, river, stream, garden, climate. Community - culture, language, beliefs, common practices)
- ability to integrate learning of science with other disciplines

2. Management

The management of the innovative curriculum depends on a administrative and supervisory system. The administrative function in the implementation would involve:

- proper official channeling of implementation plans to agencies concerned
- efficient communication, co-ordination and diffusion of the curriculum in and out of school
- linkage with the management system of other areas such as health, agriculture and industry
- provision for the necessary materials, equipment and facilities for implementing the curriculum
- guidance and supervision of teacher implementing the innovative curriculum
- provision for financial support
- monitoring of curriculum feedback on problems encountered and devising alternative strategies to solve the problems

- mobilizing the support of the community
- determining the entry point of the innovative materials in terms of time and personnel

3. Parents

The collaborative role of parents is vital in the implementation of a science curriculum that is linked to real-life situation. A well-thought of plan should provide facets for orienting and assisting parents in their roles which may include the following:

- facilitate wherever needed the home activities of students
- provide available technical assistance whenever necessary
- assist in the evaluation of progress of learners in terms of attitudes and manipulative skills
- follow-up the undertaking of the learner's activities until they are completed

4. Community

The community in which the innovative curriculum will operate should be fully acquainted with the objectives and activities of the programme. This orientation can strengthen its role.

Teacher training

As teacher will continue to remain a pivot of any teaching-learning situation, preparation to help him play his new roles, particularly when science curricula are increasingly being geared to establish linkages with real-life situations, use of the environment, locally available resources and community expertise will demand that the pre-service teacher training programmes should help him to develop the needed basic competencies. If he is to provide to his students science experiences through an activity based approach, he will himself have to learn it in the same way. The following suggestions attempt to indicate the type of actions that will have to be taken for developing new teacher training programmes:

1. As primary schools do not have a specialist science teacher and the classroom teacher has to handle all the areas of the curriculum, it is necessary to include the study of science as a compulsory subject in the teacher training curriculum.

2. The approach to learn the science content at the training institutions has to be more and more through activity based experiences closely relating theory with practice.

3. Techniques for surveying the environment, identifying local materials and community resources should form an integral part of the training.

4. As more and more reliance will have to be placed on the use of locally available materials, the training curriculum needs to make provision for the devleopment of certain basic manipulative skills in the use of simple tools to help teachers improvize simple science equipment.

5. Skills of group dynamics and human relations will need to be developed if community expertise is to be harnessed to make science teaching-learning more effective and more meaningful.

6. A variety of resource materials, mostly of the self-learning type will have to be designed for the use of teachers by the curriculum development centres with the active participation of teachers focussing on local history, geography and natural resources including fauna and flora.

7. The professional courses should be critically examined to prune them of the "dead wood", thus making way for the new learning experiences.

8. Curriculum will have to be so designed that the basic core of competencies and understanding is taken care of by the pre-service teacher training programme.

9. As evaluation is an important part of any teaching/learning activity, training in evaluation techniques, particularly focussed on affective and psychomotor domain, will have to be emphasized in the training curriculum. This will also demand the undertaking of research activities in order to develop effective tools for evaluating the learning which has taken place in the new style of activity approach with focus on process and solving of real-life problems.

10. The in-service training programmes will have to focus their main concern on updating or upgrading of content of science and orienting the teacher to the new methodologies and techniques that may be used in various science curriculum programmes.

11. Necessary mechanisms will need to be developed and established to ensure a continuous professional growth of the teacher. Attempts are already being made in this direct ion through a variety of approaches such as establishing

of Teachers Associations with support from the Ministry of Education (Japan), Primary Learning Centres (India), Decentralized Resource Centres (Philippines, Malaysia, Socialist Republic of Viet-Nam, and Sri Lanka), School Complexes, Subject Supervisors (Afghanistan and Sri Lanka) distance learning and self-instructional materials (Philippines and Socialist Republic of Viet-Nam).

Secondary level science education

Today, science education at the secondary level is addressing itself to a greater mass of students. This is a result of the expansion of educational systems that enable a larger number of students to reach this stage of formal education. A student at this stage is now expected to have attained a higher level of cognitive development. He can be exposed to a more structured science curriculum so as to provide him with the basic science understandings and processes, and skills with utility value. In all the countries attempts are being made through revised science curricula to imbue him with a better understanding of nature and the environment so that he can manipulate and use this to his advantage, at the same time creating his awareness for the need to maintain ecological balance as a matter of survival.

It should be an equally important aim of secondary level science education to equip the student with knowledge, attitudes, and skills that will enable him to play an active role in the development efforts of the country. Observation so far in the translation of this aim to actual classroom teaching shows that much emphasis is still placed on the acquisition of science knowledge for its own sake.

To date in many countries, the discipline-based science curriculum is being linked to real-life situations with examples found in the learners environment to illustrate how a particular idea or concept can be applied to a given situation. In most cases, these examples are merely cited and discussed inside the classroom. Learning activities utilizing community resources are not employed to the fullest extent.

Inclusion of practical applications to "prepare the learner for life" is still being done in a rather limited scale. The equally important components of learning - the affective and the psychomotor domains - have not been given enough attention in science teaching.

Along with the development of science knowledge, skills, and processes, an equal, if not greater, emphasis on social values and ethics should be developed in the students. They must have social awareness, a sense of responsibility to safeguard the environment, and respect for the needs of other human beings.

Linking science education to real life

Design considerations

1. Curriculum development has to be an on-going process to keep up with the rapid advances in science knowledge. There is a need to review the various science disciplines for the purpose of incorporating them in an integrated programme. In so doing, the student will have a more balanced view of science in relation to his everyday life and the environment.

2. There is a move towards an integrated science curriculum in many countries. Integration varies in scope, intensity and depth. More efforts should be exerted to attain fuller integration with the breaking down of boundaries between physics, chemistry and biology as much as possible. To begin with, this can be attempted on a few topics that lend themselves to this kind of integration.

3. Secondary science is being taught in both rural and urban schools. It is the responsibility of curriculum developers to make science learning relevant to both the rural and urban children. This does not mean a different set of science concepts for the urban and rural settings. Rather, alternative methodologies should be provided taking into account the available resources and expertise in these two types of settings.

4. Real-life situations vary from country to country as well as within a country at any point in time. Since linkage to real-life situations is achieved through environment, community resources and local expertise, there is a need to define the meaning of these terms. The following broad definitions are proposed.

> Environment is viewed in a comprehensive manner which includes social, cultural, biological and physical aspects which, directly or indirectly, affect and influence the life of an individual.
>
> Community resources are materials and facilities available in the community which can be utilized for teaching/learning situations. These include natural resources like forests, parks, water bodies, cottage industries, public utilities, museums, organizations and agencies.
>
> Local expertise refers not only to professional groups; it includes people with special skills such as carpenters, black-smiths, fishermen, artisans not normally tapped for the delivery of education but who can provide valuable contributions in this area.

5. The natural resources in the community have to be identified and utilized for teaching/learning situations. The purpose is not merely to teach the science concepts related to these resources; rather, their use and manipulation towards socio-economic

development should be taught. At the same time, the idea that they are custodians of the environment should be inculcated in the students.

6. The utilization of local expertise outside the field of education is to be considered in planning the strategies for linking learning activities to real-life situations.

7. As teachers are the main agents for helping to translate real-life situations in the science curriculum, the needed competencies of teachers should be considered and spelled out in the design.

Development considerations

In the development of curriculum materials which link science to real-life situations using environment, community resources and local expertise for teaching/learning experiences, in addition to what has already been said under this heading for primary level, the following considerations could be made:

1. To make sure that selection of topics is based on the identified needs; provision should be made for curriculum development committees to consult teachers, resource persons both from the public and private sectors of different types of communities including selected parents and local expertise.

2. In the different stages of curriculum development, ranging from the identification of objectives, determination of teaching strategies and so on, local resources, both human and material, should be tapped for their possible contribution.

3. To make provisions for varying aptitudes, abilities, and interests of the students, alternative teaching materials can be designed, e.g. in the form of modules consisting of a core for the use of all students, supplementary moduels catering to different abilities of special interest.

4. There must be more out-of-classroom activities, greater utilization of materials naturally found in the environment, and improvization of devices and equipment by students themselves. This will minimize dependence on sophisticated equipment which is not within the reach of many countries. Most important, these alternatives will contribute to the student's creativity and increased awareness of their environment.

Implementation

In relating the existing science curriculum to real-life situations, the following methodologies may be employed, in addition to whatever arrangements that may have been provided for in the curriculum programme.

Linking science education to real life

1. Building of rapport between community and schools in the form of:

a) Support for implementing the innovative curricula

b) Joint out-of-school projects to enrich the curricula

2. There must be a conscious effort for bringing in full awareness of the technological advancement through science to allow for the rural population to participate in national development, through project work as an integral part of science experiences.

3. It is important to take appropriate steps to expose and orient the teachers, administrators and others to the new programmes. This could be done in one or more of the following ways:

a) Through talks using the media (radio,T.V., newspapers)

b) Seminars and discussions

c) Through newsletters and educational journals

4. A suitable mechanism for conscious and continuous monitoring of feedback information regarding the curriculum should be made available, so as to enable the strategies to be devised and used to facilitate implementation.

Teacher training

In the existing programme for teacher education in member countries concerned there are some provisions for using real-life situations in science teaching/learning. However, though such experiences have been imparted in one form or another at the training level, situations whereby such experiences could be passed on to the pupils in the classrooms are not always available. An example in point is the programme pertaining to Work Experience/Socially Useful Productive Work (SUPW) in India. On the other hand, because relating real-life situations to science teaching/learning has not been made a specific objective in the science curriculum of many member countries, sufficient emphasis has not been given to this aspect in the science teacher education programmes.

In order to enable teachers to link the science curriculum to real-life situations effectively, the following guidelines for teacher education are proposed for consideration:

1. The teacher education programme should provide for better understanding of community resources and local expertise including their deployment for instructional purposes. Reports on community based projects, National Budget Reports, etc., could supply the necessary information and also form the necessary resource materials for reference and instruction.

2. Teacher trainees should be provided with opportunities to involve themselves in various community projects in order to acquire first hand experiences for themselves as well as the necessary insight into the community's needs and aspirations. Such projects could be in various forms, ranging from giving direct assistance to a community through a project (for example opening up a drain to help in proper drainage) to participation in a community programme (for example, helping in a land scheme, introducing improved seeds, fertilizers, etc.) The projects could be of various lengths of time, from short durations in the weekends to a longer period during vacations.

3. Teacher trainees, specializing in science teaching in particular, should be provided with experiences to acquire the necessary skills in conducting field trips and field studies, surveys and designing simple projects. These experiences would provide them with the know-how of acquiring detailed information on and acquainting themselves with the environment, the local expertise and the community resources around the schools in which they respectively teach later on. All these information would without doubt, be extremely useful to them to work out strategies to utilize real-life situations for providing science experiences to the pupils.

4. The teacher education programme should have provisions for the involvement of local expertise and the use of community resources. Local expertise need not necessarily come from within the college. As an example, locally available expertise outside the college could be sought in certain field trips or surveys. Involvement of local expertise and the use of community resources could further help to build up close rapport between the college and the community around it.

5. Teacher training programmes should provide enough opportunities for the professional growth of teachers. Apart from having such a provision as a component part of the teacher education programme, it could also come in the form of exchange of experiences gained through projects, field work etc. by which attempts are made to link science experiences and real-life experiences with one another.

6. Teacher education programme should create awareness in teachers that the needs and problems related to real-life situations are forever changing. Therefore, it must be reviewed from time to time to have the necessary aspects of it updated in order to equip the teacher trainees with contemporary skills to relate current textbook knowledge and current issues in classroom teaching to relevant real-life situations.

7. Specific evaluation instruments, particularly focused on self-evaluation as a technique, should be developed through which teacher competencies required to apply real-life situations to science teaching/learning processes could be assessed. Correspondingly, the teacher trainees should also learn techniques whereby they could test their pupils in relating science and real-life situations. Such evaluation instruments need not necessarily be in the form of paper-pencil test. They could take the form of practical project and field work, experiments and collecting of data, its proper recording and reporting, etc.

8. Where the science curriculum is an integration of the science disciplines through themes, concepts, environment, etc., the teacher education programme should enable the teachers to be fully aware of their roles in presenting such a curriculum to the pupils in a balanced manner rather than emphasizing only one discipline. Such a training situation needs to be more prominent in such training programmes which are trying to prepare teachers who would teach the science curirculum as separate disciplines.

9. The guidelines suggested above could be extended to trained teachers through in-service programmes, intensive if necessary, for more effective linking of real-life situations to teaching/learning of existing science curricula.

Upper secondary level science education

In most countries after the first two levels of education, namely the Primary and Secondary, (liberal education for citizenship, leading to certification at ordinary level) there is either two or three years of further education in a chosen area of knowledge. In most countries represented in this Workshop (except in Japan) only a certain percentage follow the upper secondary science education. This upper secondary mainly aims at getting greater understanding and competence in the selected sphere of study and life situations so that it serves the purpsoe of both those proceeding for tertiary education and those for whom this will be the terminal education (especially for the opting out for vocational streams or entering the world of work).

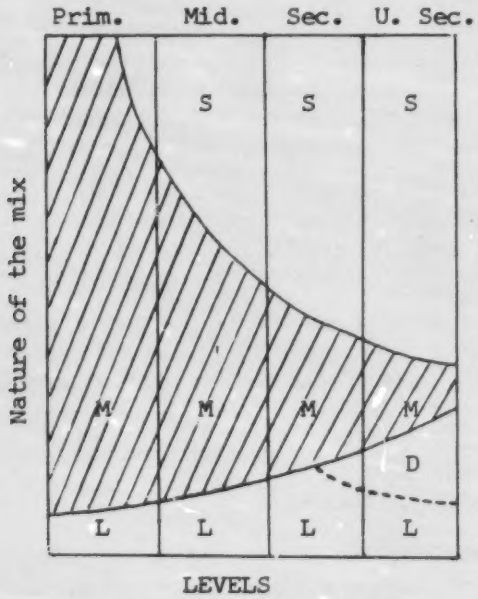
Thus, upper secondary education especially requires an emphasis on structures of discipline. The linkages with real-life situations to bring in the element of relevance will be another important consideration. The fundamental concepts, processes of inquiry, experimentation skills, application of knowledge and scientific attitudes should form the primary consideration, since understanding of science is an important vehicle for sensing and solving real-life problems. Specific local needs that lend themselves to employable skills could also form an essential component. It is at this level that supplementary programmes on development and national

priorities should be organized to support the formal curriculum for special interest groups who could be motivated. Such programmes would enable the development of the individual to meet the needs of a developing society and also provide challenging situations to arouse his curiosity and develop his creativity.

Real-life situations could be considered as falling into three groups:

1. All those experiences essential for man to live as an individual in the contemporary society.
2. Those experiences, knowledge and skills that enable an individual to understand the local and national environment and how with his scientific understanding he can control and manipulate these to his advantage.
3. The experiences and knowledge required to understand and solve problems of real-life that take priority at different times and those that are peculiar to different parts of the country.

The following diagram attempts to show the emphasis for drawing the science teaching learning content from the structure of the discipline (S), real-life situations and environment (M); specific local development concerns (L); and larger national development concerns (D).



Linking science education to real life

Under this conceptualization, the upper secondary would need more attention to special problems peculiar to the region or national priorities than the experiences essential for man or which are highly local specific.

With this as the background, the strategies for introducing real-life situations have been broadly grouped as:

1. Inputs into existing science curricula for academic streams
2. Making use of employment potential and job orientation as the real-life needs for supportive science courses for vocational education programmes
3. Supplementing the formal curriculum with out-of-school science activities for special interest and motivated groups.

To draw on real-life situations for providing science experiences the following are suggested:

Curriculum design considerations

The following are recommended as some design considerations when taking real-life situations as inputs into existing curriculum:

1. To find the felt socio-economic needs of a particular region/district such as nutritional deficiency, vocational skill, etc. Survey using questionnaires, personal interviews may form one consideration;
2. Identify national priorities (such as development of Inland Fisheries in Sri Lanka; alternate sources of energy other than fuel) which could then be analysed and form the base for development of curriculum;
3. Socially productive manual work as a component into existing curricula as has been done in Viet-Nam could form another design consideration to get students to appreciate the life experience of the community;
4. Taking a look at the out-of-school science activities in the country, especially those related to real-life problems could be an approach to develop inputs into the existing curriculum;
5. In every case of input one important aspect that needs to be considered is the identification of entry points in the different disciplines;
6. In situations where special science courses are to be developed for job oriented courses, the following points need to be considered:

a) Exploring alternate sources of 'teachers' other than the traditional teachers to man the job-oriented courses;

b) A mechanism of finding out the job potential of different districts and the resources available;

c) A method of keeping a tag on manpower needs; and

d) A mechanism of constantly bringing in the fruits of modern technology into vocations.

Some general considerations for the above guidelines are:

a) The target population at this level of school education consists of a small group going for further academic education and the rest go for various professional education courses;

b) The science disciplines should continue to have a prominent place in a most up-dated form for those who have chosen the subject areas for greater competnecies;

c) The modern technology and the research findings in the relevant field would be useful not only for those who proceed for further study but also for those who terminate and go in for vocations.

Curriculum development considerations

The overall pattern of the development of science curriculum materials for the three levels: primary, secondary and upper-secondary is very similar. The following are some special aspects at some stages of the development of science curriculum programme which may be somewhat different from those already mentioned under the primary and secondary level.

1. In the identification of problems and needs, techniques that could be used are:

a) The distribution of questionnaires and interviews to survey problems and needs;

b) Experts from departments and/or government agencies may be invited to participate in a workshop or seminar, to provide data and information concerning problems and needs of the community or of the country; and

c) Surfacing of needs and problems through various out-of-school activities related to special problems and local needs.

2. In the arrangement of content which should be based on problems and needs found, the contents of the on-going curricula should also be analysed, so that gaps could be filled to ensure that all essential concepts find a place in the programme.
3. The learning activities should be so designed that students could apply the experiences gained in their daily life.
4. The presentation should be stressed with focus on personal actions that effect the students' own environment, both at the micro and the macro-levels.
5. The local data and information should be used for effective presentation, which should not only be in the written form but also in other forms such as audio-visual aids.
6. A wide view of an application should be prepared for students, both its usefulness and harmfulness, and not only one view.

Implementation considerations

In the implementation of the science curriculum linked to real-life situations, the following aspects should also be considered:

1. Instructional materials should be available for all schools. These include both equipment and materials to be used in practical work, and audio-visual aids.
2. Evaluation techniques and instruments for the particular objectives formulated should be developed and widely used.
3. Resource centres should be established to assist teachers and provide additional experiences for students from nearby schools.
4. Follow-up programmes should also be designed and carried out to gather data and information for the revision of the curriculum.
5. In the certification process, emphasis should be given to testing those content areas that deal with real-life situations and application.
6. Local replaceable instructional materials which are suited for different surroundings should be suggested for effective implementation.

Teacher training

Two major objectives of the upper secondary stage are:

1. prepare a section of students of this stage of education to enter the tertiary level academic stream; and
2. prepare the rest of the students for jobs through vocational courses, which may be terminal in nature.

Therefore, different moduels of teacher education will have to be developed.

In addition to keeping the above objectives in mind, the following deficiencies noticed, generally, in teacher education programmes, have to be eliminated:

1. Isolation of teacher education programmes from the main stream of life, particularly the curriculum development efforts.
2. Isolation of teacher education programmes from actual teaching conditions in schools and new knowledge in science disciplines in university education.
3. Lack of relevance in the offered programmes to the actual classroom situations.
4. Lack of flexibility to include innovative aspects.
5. Lack of horizontal and vertical mobilities.
6. Focus being more on covering of courses and units rather than to develop competencies and performances.

Necessity of pedagogical exposure

Most of the students in the upper secondary classes will be in the age group 16+ to 18+. Besides, upper secondary education is accepted as the extended phase of a general secondary education. As such it is a bridge between the secondary and the tertiary level. The strategies and methodologies of teaching at either at the secondary or at the tertiary level will not be appropriate for this stage. A judicious combination of elements drawn from methodologies used in these two stages will have to be thought of. Hence, teachers of upper secondary schools should be exposed to a pedagogical training in addition to proficiency in content. This pedagogical training should not be of the same type as offered for the secondary level teachers.

Efforts will therefore have to be made in the following directions:

Linking science education to real life

1. Training programmes should be competency based and not course based.
2. Greater emphasis should be laid on 'internship in teaching' which should form the foundation of the training being offered.
3. As an essential part of teacher training programme, community service and relevant work in life-situations should be included to make teacher education more responsive to community needs.
4. Different moduels of teacher education programmes should be tried out to prepare competent teachers by offering integrated programmes of adequate duration, taking the teaching-learning processes at the upper secondary level into consideration. An example, of such an attempt is the two-year post graduate teacher education programmes offered in India through two of its regional colleges of education.

In-service training

In view of a continuous explosion of scientific knowledge, the science teachers have to be updated continuously. Professional growth is of equally great importance for teachers to meet the challenge of devising new teaching learning strategies so as to respond to this explosion of knowledge and development of new technologies. The following guidelines may be kept in mind while organizing in-service programmes.

1. The felt need of the teachers in different subject areas must first be identified before in-service programme is designed.
2. The new competencies required of the teachers as a result of curriculum changes should be specifically identified.
3. Educational administrators and science supervisors, in the light of their supervision and guidance experiences can identify the needs of teachers for organizing effective in-service programmes.
4. More and more of consultation centres/extension centres/ resource centres should be established to enable teachers to get new knowledge and clarify the concepts.
5. In-service programmes should be conducted by involving the experts in the field from systems outside of the education system also who could not only give the desired knowledge and understanding, but can also inspire the teachers.

6. Government and other agencies should make it a policy that every teacher should be exposed to orientation programmes and workshops periodically, so that their knowledge does not become obsolete.

7. In-service programmes may be of short-term or long-term, depending upon the objectives formulated for the programme.

8. Evaluation of in-service programmes by various techniques such as questionnaires to the teachers, personal discussion, follow-up and supervision should be essential.

9. In-service courses of 2 or 3 sequential phases with built-in evaluation of achievements may be allowed to earn diplomas or degree as incentives.

10. While considering teachers for promotions, their professional growth through workshops, seminars etc., should be given adequate weightage.

11. Many countries have been trying new approaches for preparation and professional growth of teachers, through distance learning using contact-cum-correspondence courses and educational technology with all its multi-media packages like broadcasts on T.V. radio. With appropriate software these could be used to prepare teachers so that they can incorporate real-life situations and environment in science teaching.

Out-of-school activity as supplementary activity to formal education for special interest and motivated group of students

This approach of bringing science closer to real-life concerns and problems by its very nature is not bound by the constraints of a curriculum. These activities could take place in out-of-school situations or even within the school boundaries like the project work.

Meeting the need of real-life situations that come up periodically or that are localized

Localized situations such as development of a lagoon for the benefit of the community, conservation of forest wealth, floods, preventing soil erosion, are problems that could draw interested students or motivate students to make scientific study of the problems with a view to finding solutions. This could take the form of a joint venture by such student groups, various developmental agencies and teachers. The design, organization, the nature of the activity would vary with the type of problem, the resources available and the background knowledge of the youth participants in that area.

Linking science education to real life

One example of such a programme is the ten year study of a lagoon in Sri Lanka which was the pivot for the development of the locality. In this programme, three objectives were built in - enrichment of science understanding obtained through formal schooling; involving the element of research and its contribution to development; and lastly physical participation in a development activity.

Experience in some of the participating countries points out that such a programme needs specially trained and highly motivated teachers who would be sensitive to developmental and real-life needs that vary from time to time and place to place. The aspects of training needed are not so much of technology and science ideas as that of organizational skills. Hence the mode of training could be best in the form of "Leader camps" where potential motivated teachers could be brought together at a centre in the locality where a particular development problem is to be investigated. Here they would have to reside for a week or more and thus experience for themselves the way to spell-out the problem, decide on the strategies and try them out. All these have to be learnt on the job including the organization and management of such activity. Some important aspects of such activities are:

1. The idea and technology are open-ended.
2. Each programme has to have its own tailor-made techniques and organization.
3. They need the interaction of experts, and in some cases the members of the community.
4. Very close and intimate teacher-student interaction as partners, preferably in the ratio of 1 to 3 or 4 students.

These have to be borne in mind in developing any training programme for teachers to prepare them for such type of activities. An experience of using such an approach is the hydro-biological survey project and establishment of field study centres in Sri Lanka; science centres in India,

Enriching formal science education programmes through the non-formal approach

Certain activities like conducting investigatory projects in school science clubs, fabrication and improvisation of scientific gadgets and their subsequent display in science fairs are increasingly being used to enrich the formal classroom science experiences. Both teachers and students benefit from such activities. Such programmes are being organized either during vacations; or as regular requirement of a prescribed course; or during free hours on school working days.

The emphasis is on enrichment of the formal curriculum and also to facilitate professional growth of teachers. Examples are pioneer palaces in Viet-Nam and science education centres in India, zoo and museum in Malaysia, field study centres in Sri Lanka.

CHAPTER IV

SUGGESTIONS FOR FOLLOW-UP ACTIVITIES AND FURTHER IMPROVEMENT OF SCIENCE PROGRAMMES

The use of real-life situations in making science curricula relevant and contributory to the attainment of development goals in many countries in Asia has been recognized as acceptable and worth-pursuing by the participants. In the light of the experiences shared and the deliberations on vital related problems and issues the Workshop suggests the following as follow-up activities:

At the national level

1. The set of guidelines formulated in this sub-regional workshop should be widely circulated by the curriculum development centres to national education bodies of participating countries for consideration in the design and development of innovative science and technology curricula and teacher education programmes.

2. Follow-up national workshops should be organized to prepare exemplar curriculum materials based on the guidelines set for primary, secondary and upper secondary levels.

3. Exemplar curriculum materials developed at each national workshop should be tried out, evaluated, revised and circulated among the participating countries as exemplars.

4. On-going science curricula in schools and teacher training institutions in member countries should be critically reviewed to determine the entry points for incorporating materials based on real-life situations.

5. Concerned agencies should give due consideration for the introduction of innovative science curricula and also work out the logistics for its subsequent implementation.

6. Curriculum development centres, teacher training institutions and other concerned divisions of the Ministry of Education should be engaged in co-operative efforts to link science curricula with real-life situations.

7. Curriculum Development centres and teacher training institutions should undertake a joint project to identify new roles/ competencies required of teachers for handling the innovative

curricula, review the on-going pre-service and in-service education programme, and in the event that such competencies are not being developed, introduce relevant experiences in the said programmes.

8. Well defined and closer linkages between curriculum development centres and teacher training institutions should be established for the effective implementation of the programme.

9. Science learning/teaching resource centres should be established complete with resource personnel cadres to help in the development of required competencies among teachers and for the dissemination of the innovative curricula.

10. The use of real-life situations as a base for science curriculum development must be recognized as a more superior strategy and attempts must be made to develop appropriate literature in a variety of forms to help the persons in authority and the community to give up the wrong notion that use of such situations would 'dilute' science.

11. There are many resources in the environment which have not so far generally been considered as educational resources for teaching science and have thus remained unutilized. Efforts therefore need to be made to identify such resources. Resources such as forests, groves in the neighbourhood should be set apart and developed for use by school pupils, teachers and other science related interest groups as a means of providing themselves with meaningful real-life experiences.

12. A radical change is needed in the examination patterns. The evaluation of pupils at examinations, must reflect the trend that real-life science experiences are most important component of science learning. For this purpose workshops should be organized to develop appropriate evaluative tools which would help the evaluations of affective and psychomotor domain concerns.

13. Appropriate strategies and mechanisms should be developed to encourage resourceful teachers to further develop topics in the curriculum, to innovatively restructure topics and groups of topics in the curriculum to further the general objectives of linking science teaching to real-life situations which at times tend to be local-specific.

14. To encourage project work by school pupils on a regular basis, especially at the upper secondary stage, on concerns of interest to the community and the nation at large - such as on conservation, solar power, pollution, improvement of traditionally manufactured products, a series of workshops should be organized, where the projects could be exhibited and the selected ones could be used to introduce such work in the regular curriculum.

Linking science education to real life

15. Recognizing the indispensability of associating specialized national institutions in curriculum development for the purposes of providing essential support for the education system and enabling the drawing of specialized knowledge of other sub-systems, institutions such as the national curriculum centres need to be fostered and further developed and provided with administrative support.

16. Specific evaluation tools be developed by each country to evaluate pupils' science achievement, practical and project work related to real-life situations and that their use be emphasized as an essential complement to traditional one shot evaluations at public examinations.

17. Inspite of the development of many innovative science curriculum,organizing of training workshops and follow-up work, there seems to be a lack of enthusiasm at the grass-roots level of implementation. One reason for this be the absence of sufficient resources for the in-service education of personnel involved in all the stages of such suggested innovative curricula. Hence, it is recommended that the policy makers be made aware of this need. The policy makers should be motivated to provide the necessary resources to the designers in order that they would be able to achieve this aim/objectives.

18. It is suggested that curriculum changes should be preceded by thorough and detailed discussions with the teacher training institutions and the community so that effective training programmes can be developed with their help and teachers trained or retrained prior to introduction of any major change.

For regional co-operation under APEID

1. ACEID should take steps to encourage the further development of national efforts at utilizing real-life situations in science teaching by sponsoring of national workshops to identify and document real-life situations which could be used as a source to develop science experiences, and disseminate the national experiences throughout the region.

2. ACEID should organize a workshop to develop co-operatively some exemplar instructional materials and related aids and equipment to concretize the guidelines suggested by this Workshop. The base for this will be provided by the national workshop efforts indicated in suggestion no. 2 under national level actions.

3. ACEID should facilitate the exchange of curriculum developers and implementors from one country to another to help them have a first-hand and on-the-job experience of designing, developing and

implementing curricula, particularly those with focus on linking science learning to real-life situations.

4. A joint innovative research project may be started under APEID to study the effectiveness of the on-going pre-service teacher training programmes for preparing science teachers and to determine what components are missing and new ones need to be added to the on-going programmes.

5. As out-of-school science activities provide an excellent opportunity to link science learning to real-life situations, thus enhancing its relevance for the learner, ACEID should organize a regional workshop on this subject to pool and analyze the available experiences and suggest further utilizing such approaches to bring science teaching/learning more closer to solving the problems of the community served by a school.

ANNEX I

LIST OF PARTICIPANTS

Afghanistan (Democratic Republic of)

Mr. Hazrat Qul Dalil
Head, Science and Mathematics Department
National Science Centre
Ministry of Education, Kabul

Mr. Mohammed Hassan Ibrahimi
Supervisor, Chemistry and Biology Department
National Science Centre
Ministry of Education, Kabul

India

Mr. S.R. Rao
Field Adviser, National Council of Educational Research and Training
714, 9th Cross,
West of Chord Road, Rajajinagar
Bangalore 560 010

Dr. G.K. Lehri
Reader in Zoology
Regional College of Education
Bhopal (M.P.) - 13

Japan

Mr. Nobutaka Ito
School Supervisor
Primary and Secondary Education Bureau
Ministry of Education, Tokyo

Mr. Shizuo Matsubara
Researcher, Science Education Research Centre
National Institute for Educational Research
Tokyo

Malaysia

Mr. Poon Poh Kong
Principal
Malayan Teachers' College
Penang

Miss Nesamalar Chelladurai
Curriculum Officer (Science)
Curriculum Development Centre
Ministry of Education, Kuala Lumpur

Nepal

Mr. Dhruba Lal Shrestha
Curriculum Development Centre
Tribhuvan University
Machali, Kathmandu

Mr. Bimal Lal Shrestha
Curriculum, Textbook and Supervision Development Centre
Ministry of Education
Harihar Bhawan, Lalitpur

Philippines

Mrs. Lourdes Carale
Science Education Specialist
Science Education Centre
University of the Philippines
Diliman, Quezon City

Miss Raquel A. Valle
Senior Educational Researcher
Bureau of Elementary Education
Ministry of Education and Culture
Arroceros Street, Manila

Socialist Republic of Viet Nam

Dr. Thai Duy Tuyen
Specialist in Science Education
Institute of Educational Science
Tran Hung Dao Street, 101
Hanoi

Mr. Bui Gia Thinh
Specialist in Science Education
Institute of Educational Science
Tran Hung Dao Street, 101
Hanoi

Sri Lanka (Democratic Socialist Republic of)

Mr. M.M. Premaratne
Chief Education Officer
Curriculum Development and
Teacher Education Division
255 Bauddhaloka Mawatha
Colombo 7

Mr. U. Wettasinghe
Education Officer
Ministry of Education
Malay Street
Colombo 2

Mr. W.S. Perera
Director of Education
Curriculum Development and
Teacher Education Division
255 Bauddhaloka Mawatha
Colombo 7

Mr. M. Atputhanathan
Education Officer
Curriculum Development and
Teacher Education Division
255 Bauddhaloka Mawatha
Colombo 7

Thailand

Dr. Pisarn Soydhurum
Head, Biology Design Team
Institute for the Promotion of
Teaching Science and Technology
924 Sukhumvit Road, Bangkok

Mr. Pongtape Boonsriroaj
Instructor, Nakonpatom Teachers
College
Department of Teacher Training
Ministry of Education, Bangkok

National Co-ordinator
(Sri Lanka)

Mr. George Mendis
Deputy Director-General of
Education (School Organization)
Ministry of Education
Malay Street
Colombo 2

Unesco

Dr. M.C. Pant
Specialist in Science Education,
ACEID
Unesco Regional Office for
Education in Asia and Oceania
P.O. Box 1425, Bangkok G.P.O.
Bangkok

ANNEX II

PROJECTS DISCUSSED DURING THE NATIONAL WORKSHOPS

Title	Contact address for further details
Afghanistan	
1. The Elementary School Science Programmes	Director National Science Centre Ministry of Education Kabul
2. The Secondary School Science Programmes	- do -
3. The Environmental Education Pilot Project	- do -
4. The Training of School Science Laboratory Technicians	- do -
India	
5. Environmental Studies Project	Director State Institute of Education Chandigarh
6. Innovative Curricula for Science and Technology Education	Director State Council of Educational Research and Training Gurgaon (Harayana)
7. Science Education Programme for Elementary School Teachers - a Unicef assisted project	Director National Council of Educational Research and Training Sri Aurobindo Marg New Delhi 16
8. Primary Education Curriculum Renewal and Developmental Activities in Community Education and Participation - a Unicef assisted project	- do -

	Title	Contact address for further details
9.	Nutrition, Health Education and Environmental Sanitation - inclusion of concepts in curriculum of primary schools - a Unicef assisted project	Director National Council of Educational Research and Training Sri Aurobindo Marg New Delhi 16
10.	Hoshangabad Science Teaching Project	Director Firends Rural Centre Rasulia, Hoshangabad (M.P.)
11.	Educational Toys Project	Principal Centre for Educational Technology National Council of Educational Research and Training Sri Aurobindo Marg New Delhi 16
12.	Vikram Sarabhai Community Science Centre	Director Vikram A Sarabhai Community Science Centre Ahmedabad (Gujrat)
13.	Grambharti Project on Development of Textbooks Linked with Rural Environment	Director Department of Education Madhya Pradesh, Bhopal (M.P.)
14.	Development of Teaching Aids in Physics and Electronics (under the COSTED teaching aid programme)	Department of Physics Indian Institute of Technology Madras (Tamilnadu)
15.	Science Teacher Education Programmes in Regional Colleges of Education	Principal Regional College of Education Manas Gangotri Mysore (Karnataka)
16.	Equip your laboratory and libraries - a science project at plus two stage	Director State Institute of Education Jammu, (J&K)
17.	Hobby Centres - a Self-generating Innovative Project	Director State Institute of Education Ahmedabad (Gujrat)
18.	Developing Innovative Physics Curriculum and Instructional Materials	Head, Post-Graduate Department of Physics Poona University Poona (Maharashtra)

Title	Contact address for further details
19. Scientific Literacy Project	Director State Institute of Education Jammu (J&K)
20. Using Environment and Local Resources for Primary Science	Director State Institute of Science Education Jabalpur (M.P.)
21. Multi-media Training Package for In-service Training of Primary Teachers	Head Educational Technology Cell State Council of Educational Research and Training Bangalore (Karnataka)
22. Integrated Community Development through Education of Science and Technology	Director Vigyan Shiksha Kendra Atara (Banda) U.P.
23. Environmental Education Project for Elementary Schools	Principal Regional College of Education Bhopal (M.P.)
Nepal	
24. Development of Science Teaching Materials from Local Resources	Director, National Curriculum, Textbook and Supervision Development Centre Ministry of Education Harihar Bhawan, Lalitpur
25. Training of School Supervisors and Master Teachers	- do -
26. Radio Broadcast Programme on use of Local Resources and Environment in Science Teaching	- do -
27. Development of Resource Materials and Guides on Performing Science Activities from Ordinary Materials	- do -
28. The New Science Curriculum	- do -
Philippines	
29. An Experimental Project on Curriculum Innovations in Bachelor of Science in Physics for Teachers (BSPT) and Bachelor of Science in Mathematics for Teachers (BSMT)	President Philippine Normal College Manila

Title	Contact address for further details
30. Deriving Activity Areas and Units of Teaching Experience in Industrial Arts	President Technological University of the Philippines Manila
31. Teacher Materials Development for Environmental Science	Director Science Education Centre University of the Philippines Diliman, Quezon City
32. Science Education for Cultural Communities: Science Teacher Training Project	President Notre Dame of Marbel College South Cotabato
33. The Experimental Elementary Education Programme (EEEP)	Director Bureau of Elementary Education Ministry of Education and Culture Arroceros Street, Manila
34. The Integrated Programme for Science Education Development for Lyete - Samar Region	Chief, Elementary Education Division Region VIII Ministry of Education and Culture Tacloban City
35. Science Modules of Project IMPACT	Director SEAMEO Regional Centre for Educational Innovation and Technology College of Education Building University of the Philippines Quezon City
36. Elementary Science Modules for Coconut/Abaca Growing Areas	Director Science Education Centre University of the Philippines Quezon City
37. Science Education in the Self-sustained Schools	President Palawan National Agricultural College Palawan
38. Physics in Farming and Fishing - Development of Modules	Director Science Education Centre University of the Philippines Quezon City

Title	Contact address for further details
39. Preparation of Science Self-Learning Kits of the In-School and Off-School Approach Programme	Superintendent Division of City Schools Manila
40. Bringing Science Education to Up-land Communities	Director Science Education Centre University of the Philippines Quezon City
41. Demarsal Fisheries Resource Management	Director Institute of Fisheries Development and Research College of Fisheries University of the Philippines Quezon City
42. Gearing the Teaching of Science to Fishery Education	Superintendent A.R. Apacible School of Fisheries Nasugbu, Batangas
43. Education Materials Integrating Science and Technology - San Salvador Project	Director Science Education Centre University of the Philippines Quezon City
Sri Lanka (Democratic Socialist Republic of)	
44. Science in the Environment Programme for the Primary School	Head Curriculum Development and Teacher Education Division 255 Bauddhaloka Mawatha Colombo 7
45. Preliminary Environment Probe of Kalu-Ganga at Naragola, Horana - A Field Study Project	- do -
46. Introduction to Secondary School Science through Astronomy	- do -
47. Pests of Common Crops in Sri Lanka - Development of Instructional Materials	- do -
48. Natural resources of Sri Lanka - Development of Resource Book	- do -
49. Hydro biological survey of the Thondari Manaru Lagoon - A Field Study Centre	- do -

Title	Contact address for further details
50. Kurulu Kele Field Study Programme	Director Curriculum Development and Teacher Education Division 255 Bauddhaloka Mawatha Colombo 7
51. School Level Monitoring of Pollution in Sri Lanka	- do -
Thailand	
52. Biology Curriculum Programme of the Institute for the Promotion of Teaching Science and Technology	Head, Biology Design Team Institute for the Promotion of Teaching Science and Technology (IPST) 924 Sukhumvit Road, Bangkok
53. Training Programmes for School Biology Teachers	- do -

ANNEX III

LIST OF DISCUSSION PAPERS
PRESENTED AT THE NATIONAL WORKSHOPS

India

1. 'Innovations in Education' - Dr. B.K. Passi, Head, Department of Education, Indore University, Indore (M.P.)
2. 'Science Curricula and Projects with Innovative Features' - Mr. S.R. Rao, Field Adviser, NCERT, Bangalore (Karnataka State)
3. 'Alternative Strategies for Developing Teacher Education Programmes' - Dr. A.A. Kayande, Professor of Science, Regional College of Education, Mysore (Karnataka State)

Malaysia

4. 'Some Experiences of Mobile Field Operational Seminar' - Mr. Poon Poh Kong, Principal, Malayan Teachers' College, Penang
5. 'The Need to Make Science Education Relevant to Human and Community Needs' - Mr. Khor Kok Peng, Research Director, Consumers' Association of Penang, 27 Kelawei Road, Penang
6. 'Innovative Efforts at Developing Science Curriculum in Malaysia' - Miss N. Chelladurai, Curriculum Development Centre, Ministry of Education, Kuala Lumpur

Nepal

7. 'Curriculum Management and Development of Instructional Materials - a Co-operative Venture' - Mrs. Chandrakala Kiran, Director, National Curriculum Textbook and Supervision Development Centre, Ministry of Education, Harihar Bhawan, Lalitpur
8. 'Objectives of Science Education' - Dr. Chandra Prakash Gorkhali, Tribhuvan Unviersity, Kirtipur, Kathmandu
9. 'Role of Applied Science and Technology in the National Development' - Dr. Kedar Lal Shrestha
10. 'Curriculum Change and Problems in Implementation' - Dr. Ganesh B. Mali, Institute of Education, Tribhuvan University, Kathmandu

11. 'Teaching Materials and Teacher Training' - Mr. Dev. Bahadur Dangol,

12. 'The Revised Science Curriculum - Some Innovations' - Mrs. Durga Regmi, Science Education Specialist, Curriculum,Textbook and Supervision Centre (CTSC), Harihar Bhawan, Lalitpur

13. 'Role of Local Resources in Teaching Science' - Mr. Bimal Lal Shrestha, Science Education Specialist, Curriculum,Textbook and Supervision Centre (CTSC), Harihar Bhawan, Lalitpur

14. 'Experiences of the Mobile Field Operational Seminar' - Mr. Dhruba L. Shrestha, Curriculum Development Centre, Tribhuvan Unviersity, Kathmandu

Philippines

15. 'Pre-service programmes on curriculum innovations at Philippine Normal College' - Prof. Carmen de la Pena, Deputy Director, NSDB-PNC, Philippine Normal College, Manila

16. 'Preparation of Vocational/Industrial Teachers' - Dr. Galicano Datu, Vice-President, Technological University of the Philippines, P.O. Box 3171, Manila 2801

17. 'Teacher Materials on Environmental Science' - Prof. Leticia E. Cortés, Chairperson, Environmental Science Workshop, Science Education Centre, University of the Philippines, Quezon City

18. 'Educational Assistance to Muslim Areas (EAMA), Project on training of para-teachers for cultural communities, Notre Dame of Marbel College (NDMC) - Bro. Renato Cruz, President, Notre Dame of Marbel College, South Cotabato

19. 'Experimental Elementary Education Programme (EEEP) - Ms. Raquel A. Valle, Bureau of Elementary Education, Ministry of Education and Culture, Arroceros Street, Manila

20. 'Science Learning Modules of the Instructional Management by Parents, Community and Teachers (IMPACT) - Dr. Efrain Abracia, SEAMEO Regional Centre for Educational Innovation and Technology (INNOTECH), College of Education Building, University of the Philippines, Diliman, Quezon City

21. 'Integrated Programme in Science Education for the Development of Lyte-Samar Region (IPSED) - Ms. Rode Navarro, Chief Educational Supervisor, MEC Regional Office No. VIII, Tacloban City

22. 'Elementary Science Modules for Coconut/Abaca Growing Area' - Dr. Carolina Perez, Chairperson, Elementary Science Workshop, Science Education Centre, University of the Philippines, Diliman, Quezon City

23. 'Self-sustaining Schools' - Prof. Miguel Palao, President, Palawan National Agricultural College, Palawan

24. 'Physics in Farming and Fishing' - Dr. Vivien Talisayon, Chairperson, Physics Workgroup, UPSEC, Quezon City

25. 'Self-learning Kits, In-school and Off-school Approach' - Ms. Edy Losaria, Assistant Principal, Arellano High School, Metro Manila

26. 'Project in Upland Communities' - Dr. Rosalina Villavicencio, Chairperson, Biology Workgroup, UPSEC, Quezon City

27. 'Demersal Fisheries Resource Management - Study and Midwater Travel Exploration in Samar Sea and Environs' - Prof. Antonio N. Mines, College of Fisheries, University of the Philippines, Quezon City

28. 'Gearing the Teaching of Science to Fishery Education in Apolinario R. Apacible School of Fisheries' - Supt. Vicente Viray, Apolinario R. Apacible School of Fisheries, Nasugbu, Batangas

29. 'Education Materials Integrating Science and Technology: San Salvador Project' - Prof. Pilar da Silva, Consultant, UPSEC, Quezon City

Socialist Republic of Viet-Nam

30. 'Unesco/APEID and the National Workshop' - Mr. Bui Gia Thinh, Institute of Educational Science, Hanoi

31. 'Some Theoretical and Practical Points Concerning the Linking of Teaching of Natural Science and Experience of Real Life' - Dr. Thai Duy Tuyen, Institute of Educational Science, Hanoi

32. 'Guiding Principle of Linking Education and Experience of Real Life - Ha Son Binh Work-cum-study School for Youths Project8 - Mr. Nguyen Huu Long, Deputy Principal, Ha Son Binh Work-cum-study School, Hanoi

33. 'Linking of the Teaching of Natural Science and Experience of Real Life - Bien Hos Secondary School, Ha Nam Ninh Project' - Mr. Bui Tien Xuong, Bien Hoa Secondary School, Hanoi

34. 'Linking of the Teaching of Natural Science and Experience of Real Life in Basic Education Schools' - Mr. Huyen Le Hoa, Institute of Educational Science, Hanoi

35. 'Linking of the Teaching of Biology and the Reality of Life, and of Productive Activities in Secondary Schools' - Mr. Nguyen Quang Thai, Department of Complementary Education, Ministry of Education, Hanoi

36. 'Linking of the Teaching of Physics and Experience of Real Life in Secondary Schools' - Mr. Ngo Van Khoat, Department of Complementary Education, Ministry of Education, Hanoi

37. 'Curricula, Syllabuses and Teaching Methods of Mathematics based on the principle of linking education and experience of real life' - Dr. Ngo Huu Dung, Institute of Educational Science, Hanoi

38. 'Some ideas about how to prepare syllabuses of physics on the principle of linking the teaching of natural science and experience of real life' - Mr. To Giang, Institute of Educational Science, Hanoi

39. 'Curricula, syllabuses and methods of teaching of chemistry based on the principle of linking the teaching of natural science and experience of real life' - Mr. Do Tat Hien, Institute of Educational Science, Hanoi

40. 'Reformed curricula of biology on the basis of the principle of linking education and real life' - Dr. Vo Van Giang, Institute of Educational Science, Hanoi

41. 'Teachers' Training and Refresher Courses organized on the principle of linking education and experience of real life' - Mr. Nguyen Huu Dung, Department of Teachers' Training, Ministry of Education, Hanoi

42. 'The school teaching of manual labour linked to experience of real life' - Dr. Tran Duc Xuoc, Institute of Educational Science, Hanoi

43. 'Building school technical facilities to serve the purpose of linking education and experiences of real life' - Mr. Tran Quoc Dac, School Equipment Firm, Ministry of Education, Hanoi

Sri Lanka (Socialist Democratic Republic of)

44. 'Inland fisheries in Sri Lanka' - Mr. M. Atputhanadan, et al, Education Officer, Curriculum Development and Teacher Education Division, 255 Bauddhaloka Mawatha, Colombo 7

45. 'Pests of common crops in Sri Lanka' - Mr. M. Atputhanadan, et al, Education Officer, Curriculum Development and Teacher Education Division, 255 Bauddhaloka Mawatha, Colombo 7

46. 'Natural resources of Sri Lanka' - Mr. N.A.C. Gunatilake, et al, Education Officer, Curriculum Development and Teacher Education Division, 255 Bauddhaloka Mawatha, Colombo 7

47. 'Hydrobiological survey of the Thondaimanaru Lagoon' - Mr. M. Atputhanathan, et al, Education Officer, Curriculum Development and Teacher Education Division, 255 Bauddhaloka Mawatha, Colombo 7

48. 'Kurulukele Field Studies Programme' - Mr. W.S. Perera, et al, Director of Education, Curriculum Development and Teacher Education Division, 255 Bauddhaloka Mawatha, Colombo 7

49. 'School level monitoring of pollution in Sri Lanka' - Mr. M. Atputhanathan, et al, Education Officer, Curriculum Development and Teacher Education Division, 255 Bauddhaloka Mawatha, Colombo 7

APEID PUBLICATIONS RELATED TO SCIENCE EDUCATION

Unesco, P.O. Box 1425, Bangkok G.P.O., Bangkok, Thailand

1. *Science in basic functional education: philosophy, approaches, methods and materials; report. 1975*

2. *Science in basic functional education: links with real-life situations; report. 1975* *

3. *Integrated science in the junior secondary school in Sri Lanka; study. 1976*

4. *Science in basic functional education; report (of a Module-Writing Workshop). 1977* *

5. *The Institute for the Promotion of Teaching Science and Technology of Thailand; study. 1977*

6. *Selection, maintenance and repair of school science equipment; report. 1978*

7. *Physics curriculum development in Asia; report. 1978*

8. *Making and using low-cost educational materials; report. 1979*

9. *Universalizing education: strategies for development and use of instructional materials, report. 1979. (includes six projects on science education, and guidelines for the design, development and use of science instructional materials).*

10. *Designing instructional materials for general education and teacher training: a portfolio of experiences in Asia and Oceania. 1980 (includes a section on science education).*

11. *Self-learning modules for teachers (two of a series already published: (i) Soil salinity and your crops; (ii) Good-bye waste).*

12. *Linking science education to the rural environment - some experiences*

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* Out of stock

The *Asian Programme of Educational Innovation for Development (APEID)*, initiated on the recommendation of the Third Regional Conference of Ministers of Education and Those Responsible for Economic Planning in Asia (May–June 1971, Singapore) and the authorization of the General Conference of Unesco at its seventeenth session (Paris, 1972), aims at stimulating and encouraging educational innovations linked to the problems of national development in the Asian region.

All projects and activities within the framework of APEID are designed, developed and implemented co-operatively by the participating Member States through their national centres which have been associated by them for this purpose with APEID.

The 20 countries in Asia and Oceania participating in APEID are: Afghanistan, Australia, Bangladesh, India, Indonesia, Iran, Japan, Lao People's Democratic Republic, Malaysia, Nepal, New Zealand, Pakistan, Papua New Guinea, Philippines, Republic of Korea, Republic of Maldives, Singapore, Socialist Republic of Viet Nam, Sri Lanka and Thailand.

The Asian Centre of Educational Innovation for Development (ACEID) has been established at the Unesco Regional Office for Education in Asia and Oceania in Bangkok to co-ordinate the activities under APEID and to assist the associated national institutions in carrying them out.

The aims of APEID are:

- to stimulate efforts of the Member States to improve the quality of life of the people through creating and strengthening national capabilities for the development and implementation of innovations in education, both formal and non-formal;
- to encourage the Member States to make all groups (students, teachers, parents, village and community leaders, administrative personnel and policy makers) aware of the need for relevant changes in education (both formal and non-formal) as an essential pre-requisite for the improvement of the quality of life of the people;
- to promote understanding and appreciation of the differences in educational practices and approaches of the Member States, and thereby contribute to international understanding and the creation of a new international economic order.